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Summer Studies of the Nearshore Fish Community at Phillips Bay, Beaufort Sea Coast, Yukon

W.A. Bond and R.N. Erickson

Central and Arctic Region
Department of Fisheries and Oceans
Winnipeg, Manitoba R3T 2N6

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by

W.A. Bond and R.N. Erickson

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PREFACE

This study was funded in part by the Northern Oil and Gas Action Program (NOGAP) through the Department of Fisheries and Oceans, Central and Arctic Region, and by the Fisheries Joint Management Committee (FJMC). It is one of a series of projects being executed under NOGAP B.2, to provide background data for assessing the implications of hydrocarbon development and production on critical estuarine and marine habitats of the Canadian Arctic Coastal Shelf. This document constitutes NOGAP Report B2.41.

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ABSTRACT

Bond, W.A., and R.N. Erickson. 1989. Summer studies of the nearshore fish community at Phillips Bay, Beaufort Sea coast, Yukon. Can. Tech. Rep. Fish. Aquat. Sci. 1676: vi + 102 p.

This report presents and discusses data concerning the relative abundance, general biology, and summer movement patterns of fish at Phillips Bay on the Yukon coast of the Beaufort Sea. Two shore-based trapnets, operated from late June until 8 September 1986, captured 142 797 fish, of which 59.2% were anadromous and 40.7% marine. Arctic cisco (62.7%) and least cisco (24.2%) were the most abundant anadromous species, followed by rainbow smelt (9.4%), Arctic charr (2.0%), broad whitefish (1.1%), lake whitefish (0.5%), and inconnu (0.1%). With the exception of Arctic charr, all anadromous fish are believed to belong to populations that spawn in the Mackenzie River system. Arctic flounder (77.3%), fourhorn sculpin (18.1%), and saffron cod (4.3%) were the dominant marine species in trapnet catches.

Movement patterns for the major species were interpreted from fluctuations in catch-per-unit-effort, time-series length-frequency distributions, and mark-recapture evidence. Trapnet results were supplemented by data obtained from gillnet and seine catches in 1985 and 1986. Water temperature, salinity, and relative water level were recorded daily or more frequently at the trapnet locations.

Keywords: Yukon coast; Beaufort Sea; migrations; CPUE; biology; life history; Arctic cisco; least cisco; Arctic charr; anadromous coregonids; marine species.

RÉSUMÉ

Bond, W.A., and R.N. Erickson. 1989. Summer studies of the nearshore fish community at Phillips Bay, Beaufort Sea coast, Yukon. Can. Tech. Rep. Fish. Aquat. Sci. 1676: vi + 102 p.

Dans le présent rapport, on présente des données sur l'abondance relative, la biologie générale et les mouvements estivaux du poisson dans la baie Phillips située sur la côte du Yukon et donnant sur la mer de Beaufort. Deux parcs en filet placés près de la côte et exploités de la fin juin jusqu'au 8 septembre 1986 ont permis la capture de 142 797 poissons, dont 59,2 % de poissons anadromes et 40,7 % de poissons marins. Le cisco arctique (62,7 %) et le cisco sardinelle (24,2 %) étaient les espèces de poissons anadromes les plus abondantes, suivies par l'éperlan arc-en-ciel (9,4 %), l'omble arctique (2,0 %), le corégone tschir (1,1 %), le grand corégone (0,5 %) et l'inconnu (0,1 %). On pense que tous les poissons anadromes, sauf l'omble arctique, appartiennent à des populations qui fraient dans le bassin du fleuve Mackenzie. La plie arctique (77,3 %), le chabot-sseau à quatre cornes (18,1 %) et la morue "safran" (4,3 %) ont été les espèces marines dominantes parmi les prises des parcs en filet.

Les mouvements des principales espèces ont été déterminés à partir des fluctuations dans les prises par unité d'effort, des distributions chronologiques de fréquences et de longueurs et des données de marquage-recapture. Les résultats provenant des parcs en filet ont été complétés par des données provenant des prises au filet maillant et à la senne coulissante en 1985 et 1986. La température et la salinité de l'eau ainsi que le niveau d'eau relatif ont été enregistrés tous les jours ou plus souvent à l'emplacement des parcs en filet.

Mots-clés : côte du Yukon; mer de Beaufort; migration; prises/effort; biologie; histoire naturelle; cisco arctique; cisco sardinelle; omble arctique; corégonidés anadromes; espèces marines.

INTRODUCTION

The fishery resources of the lower Mackenzie River and southern Beaufort Sea (Fig. 1) are of considerable cultural and economic significance to the residents of the area. Accordingly, proposed industrial developments, such as hydroelectric projects in the upper Mackenzie watershed, pipelines through the river valley, and hydrocarbon exploration in the Beaufort Sea have resulted in concerns over their potential negative impact upon fish and fish habitat. In response to these concerns, numerous studies have been funded by government and industry during the past fifteen years resulting in a substantial improvement in our understanding of the resource and its habitat requirements.

Most of the research effort to date has been directed toward the Mackenzie Delta proper (Hatfield et al. 1972; Stein et al. 1973a,b; Jessop et al. 1974; Jessop and Lilley 1975; Percy 1975; deGraaf and Machniak 1977; Taylor et al. 1982; Chang-Kue and Jessop 1983) and the area east of the delta along the Tuktoyaktuk Peninsula (Galbraith and Hunter 1975; Bray 1975; Jones and den Beste 1977; Byers and Kashino 1980; Bond 1982; Hopky and Ratynski 1983; Bond and Erickson 1982, 1985; Lawrence et al. 1984). A few studies (Craig and Mann 1974; Mann 1974; Griffiths et al. 1975; Kendel et al. 1975; Baker 1985) have focused on Yukon coastal waters but, by and large, fish utilization of Yukon coastal habitats has been little studied.

The initiation, in the early 1980's, of proposals for industrial developments at Stokes Point and King Point on the Yukon coast, and, more recently, the controversy surrounding the potential impacts of gravel-fill causeways in the Alaskan Beaufort (e.g., West Dock and Endicott causeways near Prudhoe Bay) have underscored the need for the Department of Fisheries and Oceans to improve its data base on the fishery resources of that region. The present study has sought to address that requirement, clearly recognized by the report of the Beaufort Sea Environmental Assessment Panel (1984) which recommended that, within the Beaufort coastal area, DFO should "identify and study fish habitats .....and fish species which could be sensitive to oil and gas production and transportation.....". While acknowledging the importance of marine species in the coastal fish community, this study has concentrated on the anadromous coregonids, as recommended by a 1984 workshop on research priorities for the Canadian Arctic (Thomas and Duval 1985), with particular attention to migration patterns and timing.

The present study, conducted in coastal waters in the vicinity of Phillips Bay, Yukon, was undertaken as part of the Critical Estuarine and Marine Habitat Project (B.2) of the Northern Oil and Gas Action Program (NOGAP). The stated objectives of the study were:

1. to enhance the existing data base pertaining to life history of the marine and anadromous fishes utilizing nearshore habitats along the Yukon coast;
2. to describe the longshore migratory patterns of anadromous fish during the open-water period;
3. to identify specific areas within Phillips Bay that may be of particular significance to marine and anadromous fishes as feeding, spawning, or nursery habitat; and
4. to characterize inshore habitats in terms of temperature and salinity and relate to fish distribution and movement.

During 1985, fish populations were sampled using gillnets and small mesh seines. Results of that first year's work have been summarized in Bond and Erickson (1987). The second phase of the study, conducted in 1986, concentrated on the use of shore-set trapnets to monitor the daily movements of fish. The results of that trapnetting operation form the basis of this document which represents the final report for the project.

STUDY AREA

Phillips Bay is situated at 69°15' N, 138°30' W, midway along the coast of the Yukon Territory and approximately 250 km west of Tuktoyaktuk, NWT (Fig. 1). It lies at the mouth of the Babbage River, the second largest drainage basin on the Yukon coast, and is influenced as well by the smaller Spring River which enters it on the west side (Fig. 2). The inner part of the Babbage estuary is shallow (<2 m) and is protected on the west side by Niakolik Point and on the east by Kay Point Spit, a formation of gravelly sand extending approximately 5 km into the bay from Kay Point. A similar gravel spit runs southeastward from the Spring River parallel to the mainland shoreline.

West of the Spring River much of the Yukon coastline consists of steep cliffs fronted by narrow beaches. Sediment released by the erosion of these ice-rich coastal cliffs, or delivered to the sea by the Spring and Babbage rivers, is redistributed by longshore currents. Much of it is deposited in Phillips Bay, one of three main sediment sinks occurring on the Yukon coast (McDonald and Lewis 1973). Thus, the 5 m isobath lies farther from shore within Phillips Bay than immediately east or west of it (Fig. 2).

The climatology of the southern Beaufort Sea area has been reviewed in detail by Burns (1973) and is summarized in the Beaufort Sea-Mackenzie Delta Environmental Impact Statement (Dome Petroleum et al. 1982). The climate of this region is severe and extreme temperatures at Shingle Point can range from 30°C to -50°C during the year. Mean daily temperatures are highest in July (10.6°C) and lowest in February (-27.3°C). On average, only 35 days a year are frost-free with first frost occurring as early as 10 August. Mean air temperature exceeds 0°C only from June through September. Precipitation can vary greatly along the coast, but the annual average at Shingle Point is less than 20 cm, 40% of which falls as rain during July and August.

Freeze-up along the Yukon coast begins in late September or early October. By April, most locations less than 2 m deep are frozen to the bottom, including large portions of Phillips Bay. By early winter, flow has ceased in most coastal streams and, in the absence of freshwater input, marine conditions prevail in most Yukon coastal areas. The influence of the Mackenzie River may be widespread in the southern Beaufort Sea during summer depending on winds, but under ice-cover most of its discharge is directed to the northeast along the coast of the Tuktoyaktuk Peninsula (Milne and Smiley 1976; Fraker et al. 1979) and extends westward no further than King Point (Kendel et al. 1975).

Streams of the Yukon north slope begin to flow in May or early June, well before the sea ice begins to break up (McDonald and Lewis 1973; Lewis and Forbes 1974). First flow occurs over the sea ice, promoting break-up. A large proportion of the annual flow from mountain streams such as the Babbage and Spring occurs in the first few weeks, thus large quantities of fresh water enter coastal areas at this time. The result is the annual formation of a narrow estuarine band of relatively warm, brackish water that extends from the Mackenzie River to Point Barrow, Alaska. This estuarine band provides a migratory corridor for anadromous fish, and access to much richer summer food supplies than are available in most freshwater habitats (Craig 1984). The width and exact chemical nature of this band can vary greatly and rapidly as a result of precipitation, distance from stream mouths, and the effect of wind action. However, as summer progresses and flow from coastal streams diminishes, the band tends gradually to break down until nearshore areas become dominated once again by marine waters. In late summer, therefore, anadromous fish that dispersed into coastal habitats in the spring retreat to freshwater or brackish habitats for overwintering.

MATERIALS AND METHODS

During the first year of the study (1985), the fish populations of Phillips Bay were sampled from 29 June to 21 August using variable mesh gillnets and small mesh seines. Fluctuations in catch-per-unit-effort (CPUE) produced by these gear types were used as indicators of the relative abundance and movement patterns of the various species through the study period. Captured fish were sampled for length, weight, sex, and maturity. Additionally, scale ages were determined for coregonids and stomach contents were analyzed for large Arctic cisco, large least cisco, Arctic charr, fourhorn sculpin, rainbow smelt, and saffron cod. These results are summarized and discussed in Bond and Erickson (1987).

While gillnets and seines are convenient and widely used tools for sampling fish populations, they are severely limited in terms of the kind of information they can provide. Gillnets, for example, are highly selective, both for size of fish and for species captured. Furthermore, because gillnets result in high mortality rates, they can only be set for brief periods, especially in areas such as the Beaufort coast where fish occur in large numbers. For example, in 1985, our gillnet sampling was restricted to a single two-hour set per week at each station. Such techniques, while valuable, are capable of providing only a brief glimpse of current conditions and the results obtained may easily be misinterpreted. Trapnets, on the other hand, although not without limitations, offer the opportunity for more or less continuous sampling, permitting a more complete and dynamic description of the course of events. As well, they may be less selective in terms of size and species of fish captured, and cause little mortality if attended regularly.

In 1986, therefore, our efforts focused primarily on the deployment and operation of shore-based trapnets. The objective was to assess the movement patterns of several key species on the basis of fluctuations in their CPUE and length-frequency distribution over time. For convenience in managing field operations and data presentation, the summer was divided into weekly time periods (cycles) which are referred to often in this report (Table 1). Throughout the trapnetting operation, an effort was made to hold mortalities to a minimum. Few fish were sacrificed and sampling was generally limited to identification, enumeration, marking, and measuring. Although gillnets and seines were again used in 1986, they were employed on a limited basis only, as a supplement to the trapnets.

FIELD METHODS

Trapnet sampling

The trapnets (fyke nets) used in this study were identical to those employed in recent studies of anadromous fish movements in Alaskan coastal waters (Moulton et al. 1985; Cannon et al. 1987; Fawcett et al. 1986; Glass et al. 1987). This gear has proven to be highly effective in sampling the fish species commonly found along the Beaufort coast.

The funnel mouth leading to each codend trap was supported by a stainless steel frame 1.7 m high by 1.8 m wide. Traps were 3.7 m long and 0.9 m on a side, contained five internal stainless steel frames and two throats (15x25 cm), and were constructed of 1.27 cm dark grey #147 knotless nylon mesh. Wings and leads were made of 2.54 cm dark grey #63 knotless nylon. Traps, leads, and wings were equipped with zippers, installed in such a way that they could be attached in any combination. Wings and leads were both 1.7 m deep and built in 15.2 m sections. Because of the depth of water at our location, traps were fished with 30.5 m leads rather than the 61 m leads utilized in most Alaskan studies. Wings were set at 45° angles to the lead, meaning that the effective width sampled by our trapnets was 19.75 m (i.e., from the shoreline out). This represents 39.3% of the width that would be sampled using a 61 m lead.

Our study utilized three codend traps. A single trap was established 23 June on the inside of Niakolik Point (Fig. 2). Because it was protected from wind and ice this trap fished almost continuously until the end of the field season (8 September). The other two codend traps were zippered together and fished as a dual unit with a single lead on the seaward side of Niakolik Point. Although referred to in this report as a double or dual trap, this set-up was considered to have the same catching ability as the single trap, the only difference being that fish entering from opposite sides of the lead were identifiable. It was intended that the use of such a "directional" set-up would permit the separation of coastal migrations into eastward and westward components. The dual trap was first installed on 24 June, but had to be removed from the water on several occasions in late June and early July because of wind and drifting ice. The longest such period of inactivity was six days (2-8 July). Total fishing effort was 1 812.25 h for the single trap and 1 516.75 h for the dual trap (Table 2). Traps were held in place by steel stakes driven into the sea bed.

Trapnets were checked four times daily at 0900, 1400, 1900, and 2400 h. On each occasion, trapped fish were removed from the codend to a floating holding cage for processing and the trap was reset immediately. Processing involved identification to species, counting, measuring (±1 mm), tagging or fin-clipping, and release. In this regard all species were not treated alike.

For Arctic cisco and least cisco, key anadromous species, individuals larger than 150 mm and those smaller than 150 mm were sub-sampled for fork length. These measurements were later used to calculate length-frequency descriptions of the migrant populations. For larger cisco, we attempted to measure at least 30 individuals per day from each codend trap. Quite often this number was exceeded. At times when large numbers of small cisco were captured, the number and ratio of least and Arctic cisco in one dipnet were used to provide an estimate of the total catch. In the case of broad whitefish, lake whitefish, inconnu, and Arctic charr, also key anadromous species on the Beaufort coast but not abundant at Phillips Bay, virtually all fish were measured. Similarly, for minor species such as Arctic grayling, Arctic cod, etc., all fish were measured and released. Rainbow smelt were measured to a maximum of 30 per day. For Arctic flounder and fourhorn sculpin, total length was usually recorded only for the first 10 individuals handled each day.

In order to determine residency time and, in particular, to answer the question of whether released fish were re-entering the traps and being recounted, adipose fins were removed from most Arctic cisco, least cisco, and Arctic charr captured between 23 June and 3 July. Fish of these species were routinely checked for fin-clips for the remainder of the summer. Although not identifiable on an individual basis, recaptured fin-clipped fish could be identified as having been captured initially during the 23 June - 3 July time period.

Between 5 July and 6 August, numbered Floy anchor tags (Type FD-68B) were applied to most Arctic cisco longer than 250 mm fork length. Tags were inserted into the left side of the fish near the base of the dorsal fin. It was anticipated that subsequent recaptures would yield valuable information on the timing and geographical extent of movement of individual fish.

Gillnets

Gillnets used in 1986 were identical to those employed during 1985. These were 60 m long by 1.8 m deep and consisted of equal lengths of 3.8, 5.1, 6.4, 7.6, 8.9, and 10.2 cm braided nylon mesh (stretch measure) seamed together. Gillnets were set periodically between 30 June and 30 August to provide an idea of what might be occurring offshore in terms of fish movements. In all, 23 paired surface-bottom sets were made at three locations (Sites 12, 13, and 14) along the 5 m isobath (Fig. 2). Soak time varied from 60 to 180 min. but was usually about 120 min. Gillnetted fish were retained for biological analysis (see Bond and Erickson 1987).

Seines

Six locations (Sites 7 and 8, 1 and 2, and 6 and 66) (Fig. 2) were sampled at approximately weekly intervals with 4.6 m long seines constructed of 3 mm nylon Delta mesh. This gear was intended to take small fish which might not be susceptible to capture by the trapnets. In particular, we hoped that this gear would enable us to detect the first arrival of young-of-the-year Arctic cisco in the study area. On each occasion the length of shoreline seined was measured and recorded. Large fish were measured and released. Small individuals were fixed in 10% formalin and transferred later to 40% isopropyl or 70% ethyl alcohol.

Physical and chemical

Environmental parameters measured during the study included water temperature, salinity, conductivity, and relative water level. Water samples for salinity and conductivity analysis were collected daily at each trap site during the 0900 h check (Table A1). These were transported directly to the field laboratory in 1 L nalgene bottles where salinity and conductivity were determined using a Model 33 YSI meter. Meter readings were checked periodically throughout the sampling period against prepared samples of 5°/∞ and 20°/∞ salinity. Water temperatures were measured using a hand-held pocket thermometer. Temperature readings were usually taken at each trap check at both trap locations (Table A2). Relative water levels were also recorded four times daily from a staff gauge situated inside Niakolik Point near the single trap (Table A1). In addition to the above, water temperature and salinity were also determined in association with each gillnetting or seining effort (Tables A3 and A4). Samples from 5 m depths were obtained using a 2 L Van Dorn water bottle. Air temperature and wind records for the study period (Shingle Point data) were ob-

tained from the Edmonton Office of the Department of the Environment, Atmospheric Environment Service.

LABORATORY METHODS AND DATA ANALYSIS

Trapnet catches

Ten of the fish species taken in this study were considered sufficiently important to warrant analytical attention. Of these, the three most significant by virtue of their abundance and their importance to humans were Arctic cisco, least cisco, and Arctic charr. Three additional coregonid species; broad whitefish, lake whitefish, and inconnu, while not abundant in Phillips Bay, have been included because they are of great significance in a regional context. The other species considered; Arctic flounder, fourhorn sculpin, rainbow smelt, and saffron cod, are generally abundant and widely distributed in Beaufort coastal habitats.

Catch-per-unit-effort: Utilizing the daily catch data, the CPUE for each species was calculated as the number of fish captured per hour in each codend trap. For the dual (seaward) trap, the total CPUE was the sum of the CPUE for the two individual codends; i.e., the catch for each codend was additive but effort was not. Separate CPUE determinations were made for large (>250 mm fork length) and small (<250 mm) Arctic and least cisco. The 250 mm division between large and small cisco was chosen so as to be consistent with most of the previous Alaskan studies (Griffiths and Gallaway 1982; Griffiths et al. 1983; Fawcett et al. 1986). Daily CPUE values were utilized in the case of large and small Arctic and least cisco to test for direct correlation of fish abundance with the environmental parameters water temperature and salinity.

Length-frequency distribution: The length-frequency distribution for each key species was examined by weekly sampling period for each codend trap. Changes in length-frequency distribution over time were used as indicators of movement patterns into and out of the study area. In some cases, length-frequency distributions could be used to detect movements of individual age groups. This was so, for example, in the case of young-of-the-year and age 1+ Arctic cisco where little overlap occurred between the range of lengths of the two cohorts.

Gillnets and seine catches

Fish captured in gillnets and seines during 1986 were treated as in the previous year (Bond and Erickson 1987). Catch data for these gears are summarized in this report and details are provided in appendix form (Tables A3 and A4).

Age determination

During 1985, structures retained from gillnetted fish for age determination included scales and sagittal otoliths from the coregonid species, and otoliths alone from Arctic charr, Arctic flounder, rainbow smelt, and fourhorn sculpin. In our previous report (Bond and Erickson 1987), age-length relationships were provided for the coregonid species based on scale age determinations. Otoliths have been used to assess the age-length relationships for the other species. The ages reported in this document are based on our 1985 samples, supplemented by selected samples from the 1986 trapnet catches. In some cases, trapnets were able to provide fish of sizes not captured in 1985 (e.g., small charr and smelt). The number of age determinations made is relatively small, but is considered sufficient to permit inferences concerning the age composition of trapnet catches.

Otoliths were aged using a variety of methods. In the case of large Arctic charr, otoliths were surface-read after having been hand-ground on a carborundum and cleared in methyl salicylate. The otoliths of sculpin and smelt were broken through the nucleus and the growth rings interpreted from the broken surface using reflected light. In some cases, burning the otolith over an alcohol lamp proved useful in identifying the rings. Young Arctic flounder were aged from the whole otolith using transmitted light after some surface grinding. This method was not useful, however, for fish older than about six years. Age determinations for such fish were made by the break and burn method. Cedarwood oil and 50% glycerol were found to be useful as clearing agents in most cases.

RESULTS AND DISCUSSION

ENVIRONMENTAL FEATURES AND WATER QUALITY

The coastal environment is a dynamic one, changing constantly in response to a variety of factors that include air temperature, precipitation, wind speed and direction, stream discharge, oceanographic conditions, and ice dynamics (Giovando and Herlinveaux 1981; Gilbertson et al. 1987). It is the interplay of such factors that determines the nature of coastal habitats and, thereby, the species composition of the coastal ichthyocommunity in time and space. The following sections describe some of the environmental conditions that prevailed at or near Phillips Bay during the 1986 study.

Spring break-up

On 8 June 1986, our campsite on the south shore of Phillips Bay was still covered by 0.3 to 1.0 m of snow. The Babbage River was flowing at this time (Fig. 3) and, with the exception of a band of shore-fast ice that reached about 10 m seaward, the Babbage estuary was ice-free, open water extending from Kay Point Spit to a point on the Spring River Delta between Sites 6 and 3 (Fig. 2). Otherwise, the Yukon coast was still ice-bound except to the east of Shingle Point (Fig. 1) near the mouth of the Mackenzie River.

By 19 June, when the camp was installed, the snow cover was gone from Niakolik Point ex-

cept in protected areas. The shore ice had also melted from the south side of Phillips Bay; but the position of the sea ice had changed little. This ice gradually broke up and dispersed or melted over the next three weeks, often causing difficulties in the operation of the seaward trap, especially during periods of northwest winds when chunks of ice tended to be blown onshore. Beyond 10 July (cycle 3), floating ice ceased to be a factor in trap operations.

Winds

Wind speeds recorded at Shingle Point were generally light during the first eight weeks of our study (22 June to 16 August), with only 18% percent of all observations exceeding 25 $km \cdot h^{-1}$. Winds changed direction frequently, rarely blowing from the same direction for more than a day at a time. Easterly winds (E, ENE, and ESE) predominated, especially during cycles 3, 4, and 5 (6-26 July), when 53% of all winds were from these three compass points (Fig. 4). Northwest and north-northwest winds were also important during this period. Although less frequent than easterlies, northwest winds were more likely to be strong. Between 22 June and 16 August, mean hourly wind speed exceeded 25 $km \cdot h^{-1}$ on only seven days. The predominant winds were from the northwest and north-northwest on five of these days (24 June; 10, 18, 26 July; and 13 August), while easterlies predominated on 12 and 22 July.

On 17 August (cycle 9), winds switched to the west and persisted from that direction until 24 August. Although wind direction varied during this period from south to north-northwest, the strongest and most frequent winds were from the northwest and north-northwest (Fig. 4). The peak of the storm occurred on 22 August, when mean hourly wind speed was 44.2 $km \cdot h^{-1}$ and a peak gust of 111 $km \cdot h^{-1}$ was recorded. Mean hourly wind speed exceeded 25 $km \cdot h^{-1}$ on four days during cycle 9 (17, 21, 22, and 23 August) and individual observations exceeded 25 $km \cdot h^{-1}$ 38% of the time.

South to southwest winds, uncommon through most of the summer, predominated in early September (Fig. 4), and were particularly strong on 4 and 5 September when mean hourly wind speeds were 45.0 and 26.4 $km \cdot h^{-1}$, respectively. Following 5 September, winds remained light until the end of the study period.

Air temperature

Summer air temperatures in the southern Beaufort Sea area can vary greatly from day to day and are highly sensitive to wind direction. In general, air temperatures tend to rise during periods of offshore winds but can drop to near zero during onshore winds (Giovando and Herlinveaux 1981).

Maximum daily air temperatures recorded at Shingle Point during the period of our 1986 study ranged from 1 to 26°C (Fig. 5). Day-to-day changes in daily maxima were usually less than ± 5°C (69% of the time), but differences of 10°C or more occurred on six occasions. Such large day-to-day variations were most common early in the summer when the sea ice was still close to shore, and a shift in wind direction could produce a rapid reduction in air temperature.

Maximum daily air temperatures were low through early June but rose rapidly after mid-month. Under the influence of predominantly easterly winds, air temperatures remained quite warm throughout the first eight weeks of the study (22 June - 16 August), with the mean daily maximum ranging from 13.4°C in cycle 5 to 19.1°C in cycle 4 (Table 3; Fig. 5). The period of prolonged northwest winds that began in the week following 16 August took daily maximum air temperatures to near 0°C, and the mean daily maxima for cycles 9 and 10 (17-30 August) were just 8.1 and 6.4°C, respectively (Table 3; Fig. 5). Air temperatures rose again in early September as strong southerly winds swept over the mountains, then fell rapidly during the last ten days of the month (Fig. 5).

Water level

Water levels at Phillips Bay varied over a range of 80 cm in 1986, triple the average tidal fluctuation of 25 cm expected on the Yukon coast (Kendel et al. 1975). Intraday variations ranged from 8 to 43 cm ($\bar{x}$ =19.8 cm), but were between 15 and 24 cm 61% of the time and between 10 and 29 cm 90% of the time.

Water levels generally declined over the first five weeks of the study under the influence of persistent east winds, reaching their lowest values between 22 and 24 July (Fig. 6). A change in wind direction sometimes produced very rapid water level responses. For example, strong north-northwest winds on 10 July raised the relative water level from 33 cm to 72 cm. A subsequent return to strong east-southeast and east winds on 11-12 July reduced the level to 15 cm. The extent of this variation is not fully reflected in Fig. 6.

The more variable winds experienced in cycle 6 (Fig. 4) allowed water levels to rebound from their lowest values, and levels continued to vary within a relatively narrow range through cycles 7 and 8. Maximum water levels occurred on 22 August (Fig. 6) as a result of the major northwest storm that crossed the study area during cycle 9. A decrease in these northwest winds and a subsequent change to a southerly wind direction allowed water levels to recede again in late August and early September.

Water temperature and salinity

Water temperature and salinity are the habitat parameters generally considered to be of greatest importance in determining the distribution and movements of anadromous fish in Beaufort coastal waters (Craig and Haldorson 1981; Griffiths et al. 1982, 1983; Craig 1984; Cannon and Hachmeister 1986; Gilbertson et al. 1987). Nearshore waters, cold and saline under winter ice cover, are warmed and freshened in late May and early June by spring runoff from coastal streams. The warmest, freshest areas are found

near the mouths of rivers such as the Babbage. However, wind-driven currents translate the effect along the coast, resulting in the establishment of a narrow estuarine band that extends westward to Point Barrow. Craig (1984) discusses the nature of this brackish band and its significance to anadromous and marine fish.

Complete water temperature and salinity data collected from Phillips Bay in 1986 are given in Tables A1 and A2. The patterns observed at the trapnet locations (0900 h) during the study period are shown in Fig. 7 and 8.

Overall, water temperatures at the trapnet locations ranged from 2.5 to 15.0°C while salinity varied from 0.0 to 21.8°/∘∘. In late June, Phillips Bay was still dominated by Babbage River (and to a lesser extent, Spring River) flood waters, and little mixing had occurred with colder marine water. Throughout this period (cycle 1), salinities at the trap sites remained at 0.0°/∘∘, and a lens of warm, fresh water extended outward from the river mouth, overlying colder marine waters farther offshore. On 30 June, for example, readings taken at Site 12 on the 5 m isobath (Fig. 2) showed surface water to be 9.5°C and 0.5°/∘∘ salinity while at the bottom, temperature and salinity were 2.0°C and 10.8°/∘∘, respectively.

By the beginning of cycle 4 (13 July), increased mixing caused by wind activity, combined with a decrease in Babbage River discharge (Fig.3) resulted in a highly variable temperature-salinity regime at the trapnet sites (Fig. 7 and 8). Throughout cycles 4 to 8, offshore (easterly) winds tended to blow surface waters seaward, resulting in upwellings that often raised salinities on the seaward side of Niakolik Point to near 20°/∘∘. Northwesterly (onshore) winds, especially moderate winds of short duration, tended to restrict the seaward movement of river water, reducing salinities and raising temperatures at the shoreline.

The effect of the August storm can be seen particularly in Fig. 7, as water temperatures at the shoreline decreased to 2.5°C. Although nearshore temperatures rose again to the 6-8°C range following the storm, data from offshore stations suggest that marine water was beginning to overtake Phillips Bay by the end of August. By 29-30 August, surface temperatures at the 5 m isobath ranged from 3.0 to 4.0°C while temperatures of 1.0 to 2.0°C were recorded at the bottom. Surface salinities varied from 17.5 to 23.8°/∘∘ at this time, while at the bottom, salinity ranged from 21.8 to 28.2°/∘∘.

It was apparent during the study that Niakolik Point (and Kay Point Spit) tended to confine Babbage River discharge within the inner bay, thus limiting the degree of mixing. The result was that water inside Niakolik Point was usually warmer and less saline than that on the seaward side (Fig. 7 and 8). Where across-spit comparisons were possible, inside water was warmer 90.5% of the time. On those occasions when warmer temperatures prevailed on the seaward side of Niakolik Point, the difference was usually less than 2°C. On the other hand, when inside waters were warmer, a differential of 4°C or greater was observed 9.1% of the time (maximum 7.0°C).

Salinities ranged from 0.0 to 18.0°/∘∘ at the single trap site and from 0.0 to 21.8°/∘∘ on the outside of Niakolik Point. The largest across-spit differential (18.8°/∘∘) was observed on 5 August and, after mid-July, differences of 10.0°/∘∘ or greater occurred on 29 occasions (53.7% of the time). Similar temperature and salinity differences were observed at other shoreline locations both in 1986 (Table A4) and in 1985 (Bond and Erickson 1987).

Correlation between water temperature and salinity

In the brackish waters of the Beaufort coast, a strong negative correlation is usually observed between salinity and water temperature (Griffiths and Gallaway 1982; Griffiths et al. 1983; Cannon et al. 1987; Glass et al. 1987). This generalization held at the seaward station during the present study ($r=-0.34$; $P<0.01$). On the inside of Niakolik Point, however, no significant correlation was detected between these two important parameters ($r=-0.15$; $P>0.05$).

As indicated previously, the water on the inside of Niakolik Point was usually warmer and less saline than on the seaward side of the point. The difference in the temperature-salinity relationship between the two locations probably results from an overriding influence of solar heating on the waters of the inner bay. Glass et al. (1987) indicate that solar warming of high salinity water within shallow embayments can have a weakening influence on the relationship between temperature and salinity.

FISH

Nearshore waters of the Beaufort Sea provide important habitat for about 40 species of fish. These are mainly anadromous or marine forms although small numbers of freshwater species are sometimes taken near river mouths. The fauna is dominated by a small number of species whose relative abundance varies according to location and time of year. A recent review by Craig (1984) summarizes the generally observed patterns of habitat utilization within the nearshore zone by the major fish groups.

Anadromous species enter coastal waters at spring break-up, disperse along the coastal margin and, after a period of summer feeding, return to river systems to spawn or overwinter. The extent of longshore migrations varies considerably between species. As their name implies, marine species complete their entire life cycle within the Beaufort Sea. Some of these are common in brackish nearshore habitats during the summer but are forced into deeper areas as the sea ice thickens over the winter. These marine species are not believed to undertake longshore migrations as described for the anadromous forms.

Species composition

Twenty-one fish species representing eleven families were captured in Phillips Bay during the two years of this study (Table 4). The 1986 trapnets took 20 species, including seven that had not been captured the previous year.

The total trapnet catch was 142 797 fish, of which 59.2% were anadromous and 40.7% marine. Freshwater species accounted for just 0.1% of the catch (Table 5). Among the seven anadromous species Arctic cisco predominated, accounting for 62.7% of the total. The majority of Arctic cisco taken (81.0%) were small fish (<250 mm). Least cisco was second in abundance among the anadromous species, contributing 24.2% of the catch. Large (50.3%) and small (49.7%) least cisco were equally represented in the catch. Other anadromous species included rainbow smelt (9.4%), Arctic charr (2.0%), broad whitefish (1.1%), lake whitefish (0.5%), and inconnu (0.1%). Arctic flounder was the dominant marine species in trapnet catches, comprising 77.3% of all fish in that group. Fourhorn sculpin (18.1%) and saffron cod (4.3%) accounted for most of the remaining marine specimens.

Overall, more fish were captured in the dual trap on the seaward side of Niakolik Point (58.4%) than in the single trap on the protected side (41.6%). The results varied by species, by size of fish, and over time. Table 6 indicates how the numbers of each fish species taken varied among the three codend traps. For the five anadromous coregonid species, the total catch was equally divided between the protected and seaward traps. However, for the anadromous rainbow smelt, the majority (71.9%) were taken on the seaward side. Similarly for the three most common marine species, catches tended to be largest on the seaward side of the point (67.9%). The vast majority of fish captured in the dual trap (73.0%) were travelling in an easterly direction (toward the end of Niakolik Pt.) at the time of capture (Table 6). This generalization was particularly evident in the case of small Arctic cisco (91.4%) and small least cisco (80.0%). The reason for this is unclear, but may be related to the configuration of the coastline in Phillips Bay, to current patterns within the bay, or to other factors. At any rate, the numbers taken in the "directional" trap represent a description of smaller scale directional tendencies of these fish and should not be used to infer the larger scale longshore migratory picture.

Because the fishing time for the single and dual traps differed (Table 2), it is more realistic to examine catch-per-unit-effort data than absolute numbers. Overall CPUE figures for the major species by individual codend trap are presented in Table 7. These figures show that while CPUE for large Arctic and large least cisco was about twice as high at the seaward trap, catch rates for small cisco were approximately equal on the inside and seaward side of Niakolik Point. CPUE for rainbow smelt, Arctic flounder, fourhorn sculpin, and saffron cod was higher on the seaward side of the spit.

Gillnets, set at three locations along the 5 m isobath, produced only 159 fish of seven species (Table 8). Arctic cisco (90.6%) accounted for the majority of gillnetted fish. As in the previous year (Bond and Erickson 1987), broad whitefish, lake whitefish, and inconnu were not captured at offshore locations. Complete information relating to each gillnet set is presented in Table A3.

Small mesh seines produced a total of 2 130 fish of eight species with fourhorn sculpin (50.5%) and Arctic cisco (38.5%) accounting for the majority. The total seine catch for each species by sampling location is summarized in Table 9. Complete catch data including the number of each species captured, its percentage frequency of occurrence, and its CPUE by location in each weekly sampling period are presented in Tables A4.1 to A4.10.

Correlation of fish abundance and habitat parameters

Numerous studies have demonstrated that, during their summer foraging migrations along the Beaufort coast, anadromous fish tend to remain within the relatively warm, brackish nearshore zone and to avoid the cold, saline conditions prevailing offshore (Furniss 1975; Bendock 1979; Craig and Haldorson 1981; and others). In doing so, they expose themselves to an environment of considerable instability, in which conditions may change quickly over wide ranges. Some species, such as Arctic cisco, appear better adapted to this rigorous environment than others, such as broad whitefish, and this is reflected in obvious inter-specific differences in coastal distribution and life history pattern (Reist and Bond 1989).

Of the many parameters that constitute the total environment, those thought to be most important in directing the distribution and movements of anadromous fish are temperature and salinity. There is general agreement that for both large and small coregonids, abundance tends to correlate positively with water temperature and negatively with salinity (Griffiths and Gallaway 1982; Griffiths et al. 1983; Moulton et al. 1985). Most studies, however, have concluded that only a small proportion of the variance in CPUE can be attributed to either of these parameters. This is probably not surprising in an environment in which the inherent variability of many factors is so great.

During the present study, we employed daily CPUE values and 0900 h temperature and salinity readings to measure the degree of linear correlation between fish abundance and each of these environmental variables for large and small Arctic and least cisco. Separate determinations were made for each collection site, i.e., outside and inside Niakolik Point (Table 10 and 11). CPUE showed no correlation with water temperature for either species or size cohort with the exception of large least cisco, where a significant ($P<0.05$) positive relationship was observed at the sheltered site on the inside of Niakolik Point. In the case of the CPUE-salinity determinations, however, several

significant correlations were observed. For large Arctic cisco a significant ($P<0.001$) negative correlation was observed at the inside location but not at the seaward site. Abundance of small Arctic cisco showed no correlation with salinity. Significant negative correlations occurred between salinity and abundance of large least cisco at both trapnet locations. In the case of small least cisco, the CPUE-salinity relationship showed no correlation at the inside location but a significant ($P<0.05$) positive correlation at the seaward site.

Despite the occurrence of several significant correlations, temperature and salinity accounted for a relatively small proportion of the observed variability in CPUE for either size cohort of either species. The actual percentages were: large Arctic cisco - 17.5% (inside trap), 2.5% (outside trap); small Arctic cisco - 2.2 and 1.1%; large least cisco - 13.8 and 16.7%; small least cisco - 3.6 and 9.8%. Considering the many variables that comprise the environment and the fact that, as Neill and Gallaway (1989) asserted, fish respond to the "totality of the environment", rather than to individual components of it, the above results are not unexpected.

MOVEMENT PATTERNS

The primary purpose of the 1986 study was to describe the longshore migratory patterns of anadromous fish throughout the open-water period. It was assumed at the outset that these fish migrate eastward and westward along the Yukon coast during the summer, a position held by most previous studies (Mann 1974; Craig and Mann 1974; Kendel et al. 1975; Griffiths et al. 1975; Baker 1985). Our approach was to intercept these migrations at Phillips Bay and to monitor their progress over time. Fluctuations in CPUE and in length-frequency distribution were interpreted as evidence of fish movement. The residency time in Phillips Bay of Arctic cisco, least cisco, and Arctic charr was assessed by the release of marked fish, while an attempt was made to evaluate the geographic extent of Arctic cisco movement through tagging. The following section represents the results of these efforts for each coregonid species, for Arctic charr, and for rainbow smelt, Arctic flounder, fourhorn sculpin, and saffron cod. Where appropriate, we have tried to integrate our 1986 results with those of the previous year (Bond and Erickson 1987).

Arctic cisco

Abundance and catch-per-unit-effort: Large fish (>250 mm) made up 19.0% of all Arctic cisco captured in trapnets. They tended to be more abundant on the outside of Niakolik Point where 63.5% of the total catch was taken (Table 6). CPUE at the dual trap (4.21) was more than double that recorded at the inside location (2.02)(Table 7).

Large Arctic cisco were already present in Phillips Bay when sampling began on 23 June. Although catch rates showed large fluctuations, both between days and between traps (Fig. 9; Tables A5.1 and A6.1), definite seasonal trends are evident when the data are combined on a weekly basis (Fig. 10). The heaviest catches of large Arctic cisco were made in the first four weeks of the study as 51.2% of all large cisco were taken between 23 June and 19 July. Overall CPUE during this period was 5.10 fish per hour, the highest weekly value (6.61) occurring in cycle 2 owing to a very large catch on 1 July (n=1 009).

Following cycle 4, CPUE decreased and averaged only 1.17 through cycles 5-8 (20 July-16 August). Although overall abundance was low during this midsummer period, several pulses occurred in the catches from the dual trap (Fig. 9), indicating the passage of small schools of cisco. CPUE rose sharply again in late August and early September to reach 4.93 during cycle 11, a level approximately equal to that recorded during weeks 1-4.

The majority of Arctic cisco taken in trapnets (81.0%) were small individuals (<250 mm). Although more small fish (55.0%) were captured on the inside of Niakolik Point (Table 6), the overall CPUE values were approximately equivalent (12.98 vs 12.88) at the two locations (Table 7).

Small Arctic cisco (Tables A5.2 and A6.2) were rarely captured during the first four weeks of trapnetting, and seining results confirmed their absence from Phillips Bay at that time. After 20 July, however, capture rates increased (Fig. 11), reflecting the arrival in the study area of large numbers of young-of-the-year (mostly) and yearling fish. The period of most intense migratory activity for these small fish appeared to be from about 6-18 August, peaking in cycle 7 during which an overall CPUE of 32.17 was recorded (Fig. 12). The largest daily catch (n=6 445) occurred on 7 August when 5 825 small Arctic cisco were taken in the single trap.

Following the abundance peak of cycle 7, catch rates decreased sharply, reaching a low level of 8.41 in cycle 10 (Fig. 12). This decline was, in all likelihood, attributable to circumstances related to the severe storm that moved through the area at that time. With the passing of the storm, CPUE rose again, and averaged 20.86 over the last nine days of the study. Large numbers of small Arctic cisco were still present in Phillips Bay at the end of our sampling period.

Length-frequency distribution: Fork lengths were recorded for 9 483 trapnetted Arctic cisco. Lengths recorded from individual codend traps and within sampling periods are summarized in Tables A7.1 to A7.3. When considering these numbers it is important to remember that they represent the combination of two different subsamples (<150 mm and >150 mm) as described in the methods section. By applying the ratios obtained within the measured subsamples to our total counts, it was possible to describe the length-frequency distribution of the migrant population both on a weekly and overall basis.

Trapnetted Arctic cisco ranged in fork length from 35 to 488 mm and the overall length-frequency distribution was strongly bimodal (Fig. 13). Among large fish (>250 mm), those between 320 and 379 mm accounted for 62.8% while 90.6% fell within the 280-399 mm range. Fish of this size have dominated the catch in most gillnet surveys conducted along the Beaufort coast (Craig and Mann 1974; Griffiths et al. 1975, 1977; Kendel et al. 1975; Baker 1985). During 1985, 73% of gillnetted Arctic cisco in Phillips Bay were between 325 and 399 mm fork length (Bond and Erickson 1987). Similar results were observed in our 1986 gillnet catches (Table 12) where fish in the 300-374 mm range accounted for 82.5% of the total.

On the basis of our 1985 results (Bond and Erickson 1987), it is likely that the majority of large Arctic cisco taken in the trapnets were 6-9 years of age, and either immature (virgin) fish or mature non-spawners. During 1985, only 7% of males and 16% of females were judged capable of spawning in the approaching spawning season. Although males outnumbered females by a wide margin overall in that sample, females (58.7%) were more abundant among mature fish. Most mature individuals (98% of females and 79% of males) exceeded 350 mm in fork length.

Among small Arctic cisco (<250 mm) the vast majority (96.6%) were less than 150 mm in length. Those between 50 and 79 mm contributed 61.6% of the total. The smaller mode in the length-frequency distribution (Fig. 13) consists primarily of age 0 and age 1 fish. The paucity of fish in the 150-279 mm range is believed to reflect a general absence of 2- to 5-year-old individuals. Fish of this size accounted for just 4.2% of the total trapnet catch.

Over the course of the summer the length-frequency distribution for trapnetted Arctic cisco varied. This has already been suggested in the preceding CPUE analysis but is portrayed more dramatically in Fig. 14. As a percentage of the total catch, large cisco were predominant during the first four weeks of the study. Following cycle 4, their absolute abundance declined (as discussed earlier), and their contribution in percentage terms dropped sharply owing to the passage of large numbers of small fish (<150 mm) through the study area. An increase in abundance is apparent during the last four weeks of the study period. These large Arctic cisco, primarily in the 280-399 mm range, represent the portion of the population that was sampled by our gillnets in 1985 when a consistent modal length range of 350-374 mm was recorded (Bond and Erickson 1987).

Considering Arctic cisco smaller than 150 mm, it is evident that few were present during the first four sampling periods (Fig. 14). Those appearing in our catches between 4-19 July were primarily age 1 fish in the 70-109 mm range. Yearlings remained prevalent in the catches throughout the summer and by late August or early September this cohort displayed a modal fork length in the 110-119 mm size range.

Young-of-the-year (age 0) Arctic cisco were first captured in trapnets during cycle 4 (13-19 July) at a modal fork length of 40-49 mm. This cohort arrived en masse during cycle 6 (modal length 50-59 mm) and, as indicated earlier, peaked in abundance during cycle 7. They remained the dominant size group in Phillips Bay from late July to early September, maintaining a constant modal size of 60-69 mm from cycle 7 onward.

It became apparent during the course of the study that the trapnets, constructed as they were of 1.27 cm mesh, were limited in their ability to sample age 0 Arctic cisco, and were not highly effective until the fish had attained a length of about 50-60 mm. Small fish were often seen swimming through the mesh. This gear selectivity explains the obvious discrepancy between the length-frequency distribution for young cisco captured in the trapnets and those taken in seines (Tables 13 and 14). Of all small Arctic cisco taken in seines, the majority (72.2%) were between 35-49 mm fork length. During the previous summer, 76.8% of seine-caught small Arctic cisco were between 30-49 mm fork length (Bond and Erickson 1987).

Results of seining operations indicate the first arrival of young-of-the-year Arctic cisco in Phillips Bay on 11 July (n=1; 25 mm). They did not become abundant in seine hauls until cycle 5, however, and showed their highest CPUE in this gear during cycle 6 (27 July-2 August) (Tables A4.1 to A4.10).

Recapture of marked fish: A total of 4 795 large Arctic cisco were marked during the study. Approximately 2 000 were fin-clipped during the first ten days of field operations while Floy tags were applied subsequently to 2 795 individuals. Floy tagging covered the period 5 July-6 August. Overall, the majority of marking was accomplished during cycles 1-4, corresponding to the time of high early summer abundance for large Arctic cisco.

Only 25 marked Arctic cisco were recaptured, a recovery rate of just 0.5% (Table A8). Eight fin-clipped fish were recovered in the traps, three of which were taken in June, shortly after their release. The other five individuals were recaptured at Phillips Bay between 25 August and 2 September, having been at large for between 54 and 62 days.

In addition to the fin-clipped specimens, 10 Floy-tagged Arctic cisco were recaptured during 1986. Four recaptures were made in Phillips Bay; one of these was taken within 48 hours of release, while the others were recaptured on 26 July, 28 August, and 1 September, 18, 45, and 52 days after their respective release dates. Five tagged cisco were returned from Shingle Point on the Yukon coast east of Phillips Bay (Fig. 1). These were recaptured between 16 July and 14 August, seven to 29 days after their release. A single recapture was reported from the Peel Channel of the Mackenzie Delta on 20 October, after being at large for 86 days.

During 1987, six more recaptures of tagged Arctic cisco were reported (Table A8). All were taken in the Mackenzie Delta between mid-August and October. On 15 August 1988, a Floy-tagged Arctic cisco was recaptured at Barter Island, Alaska, approximately 200 km west of Phillips Bay. This is the only recapture reported to date from any location west of Phillips Bay.

Summary: Arctic cisco is the most widely distributed of the anadromous coregonid species that occupy Beaufort coastal habitats during the summer period (Craig and Mann 1974; Kendel et al. 1975; Griffiths et al. 1975, 1977; Craig and Haldorson 1981; Griffiths and Gallaway 1982; Griffiths et al. 1983; Lawrence et al. 1984; Baker 1985; Moulton et al. 1985; Cannon et al. 1987; Glass et al. 1987). It supports domestic and commercial fisheries in Alaska's Colville River Delta (Moulton and Carpenter 1986) and forms an important component of subsistence harvests in Mackenzie Delta communities.

Until recently a great deal of confusion surrounded the Arctic cisco of the Beaufort coast. Spawning was believed to occur in both the Mackenzie and Colville rivers; older juveniles and mature fish were known to enter coastal areas, but few small fish had been taken in surveys, and the movements of fry and young juveniles were poorly understood. Further, the nature of the relationship between Mackenzie and Colville fish was not known (Griffiths et al. 1975; Craig and McCart 1976).

A major source of confusion lay in the fact that, although fry had been captured within the Colville Delta (Kogl and Schell 1974), there was an unexplained absence of ripe or spent fish in the Colville Delta fishery, and no spawning run into the Colville River had ever been documented.

In an attempt to explain the observed distribution of Arctic cisco, Gallaway et al. (1983) discarded the previously held notion that the large population known to occupy the Colville Delta is derived from spawning grounds within the Colville system. Instead, they hypothesized that all Arctic cisco associated with brackish waters of the Canadian and Alaskan Beaufort coast originate from spawning areas within the Mackenzie River system. These authors suggested a scenario in which cisco migrate westward from the Mackenzie to the Colville as young fish, remain to rear in the vicinity of that river for several years, and then, upon achieving first maturity, return to the Mackenzie to spawn.

This hypothesis concerning the life history of Arctic cisco has gained wide acceptance over the past few years as evidence in support of it continues to accumulate. While not necessarily the final answer in the sense of describing the movement patterns of Mackenzie River cisco, it has provided an important new framework within which to evaluate the results of Beaufort coastal fishery studies and is worth bearing in mind when reviewing the results of the current study.

Despite the fact that eastward and westward migrants could not be identified separately by this study, the pattern of CPUE values observed suggests an early summer dispersal of large Arctic cisco westward along the Yukon coast and a late summer return to the Mackenzie Delta. Although limited in number, recaptures of marked fish seem to support such a scenario. Trapnetting results indicate that, in 1986, the westward migration had reached Phillips Bay by 23 June. Our failure to recapture many marked fish in the period immediately following their release suggests that these fish had a very brief residency period within Phillips Bay and were, in fact, migrating actively past Phillips Bay at the time of their capture. The main body of the westward migration had passed our location by mid-July. The return migration toward the Mackenzie Delta began to pass Phillips Bay in late August. The results of this study, therefore, support the seasonal pattern of coastal movements suggested by Kendel et al. (1975) and others for large Arctic cisco.

Having passed Phillips Bay, the westward migration of large Arctic cisco continues for some distance along the Beaufort coast although the limit of this movement is uncertain. It extends at least to the vicinity of Herschel Island where large Arctic cisco are known to be abundant during July and August (Griffiths et al. 1975; Baker 1985). Although they appear to be less common in the central Beaufort area (Griffiths et al. 1977; Wiswar and West 1986), it had been thought that some westward migrants might reach Barter Island, mid-way between the Mackenzie and Colville rivers. The recent capture of one of our tagged fish at Barter Island confirms the movement of large Arctic cisco into Alaskan waters.

While the return migration toward the Mackenzie appears to commence in late August, Griffiths et al. (1975) noted that many large cisco still remained in Nunaluk Lagoon, just west of Herschel Island, at freeze-up. They suggested that some of the eastward return migration must occur under ice cover.

This group of large cisco that disperses along the Beaufort coast from Mackenzie Delta overwintering sites includes juveniles, mature non-spawners, and mature spawners. By most accounts, juveniles and mature non-spawners dominate this cohort in coastal habitats during the summer, and this was also our observation (Bond and Erickson 1987). Different migratory patterns of fish that differ in their state of maturity may account for this. Spawners, for example, as suggested by Griffiths et al. (1975), may not disperse as far from the Mackenzie as non-spawning individuals and may return to the Delta earlier. At Tuktoyaktuk spawners were seldom captured after the end of July (Bond 1982). Similarly, at Phillips Bay, we found the frequency of mature spawners to be higher in early summer than later on.

Not considered in the above discussion is the group of large Arctic cisco which, according to theory (Gallaway et al. 1983), had reared in Alaskan waters and which, in 1986, were return-

ing to the Mackenzie system to join the spawning population. These first time spawners are believed to begin this eastward migration soon after leaving their overwintering areas in late June or early July (Reub et al. 1988). Such fish may have been present in our Phillips Bay catches but could not be identified with certainty. Although five individuals, tagged near Prudhoe Bay, Alaska between 8 July and 1 August 1985, were recaptured in Phillips Bay between 27 June and 1 September 1986, we have no way of knowing whether these fish had spent the previous winter in Alaskan or Canadian waters.

Nevertheless the capture, during our study, of these and three other Arctic cisco that had been tagged in the vicinity of Prudhoe Bay is highly significant, as is the subsequent recovery of six additional Alaskan tags within the Mackenzie Delta. They provide additional evidence in support of the Gallaway et al. (1983) hypothesis.

Trapnetting studies such as the present one have shown that small Arctic cisco (<250 mm and particularly <150 mm) are much more abundant in Beaufort coastal waters than had been indicated by earlier gillnetting and seining studies (Bendock 1979; Griffiths and Gallaway 1983; Moulton et al. 1985; Cannon et al. 1987; Glass et al. 1987). The appearance of young Arctic cisco at Phillips Bay in mid-July, and their subsequent documented arrival at progressively more westerly locations, and ultimately at the Colville River by late August was reported in 1985. This is seen as evidence of a westward migration of Mackenzie River young to rearing areas in Alaskan waters (Fawcett et al. 1986; Bond and Erickson 1987).

Apparently 1986 was another year of heavy recruitment of young Arctic cisco into the Prudhoe Bay area (Cannon and Machmeister 1987). Our results at Phillips Bay indicate that young fish (primarily age 0 but including some 1-year-olds) began passing our location in the last half of July and continued to do so in large numbers through early September. Glass et al. (1987) report the subsequent arrival of young-of-the-year cisco in Prudhoe Bay during the second week of August. These small fish dominated trapnet catches in the vicinity of Prudhoe Bay by 22 August, and remained in that study area until late September when sampling ceased.

The poor representation in our catch of intermediate-sized Arctic cisco (150-279 mm) seems to be a common phenomenon in Beaufort coastal waters to the west of the Mackenzie Delta. At one time the failure to capture fish in this size range was attributed to the selective characteristics of the sampling gear being used. However, with the recent use of trapnets, this argument no longer appears plausible. Rather, it seems more likely that the virtual absence of such fish in central Beaufort habitats is a reflection of the life history pattern of this species. Given the life history pattern described above, it is a situation that might be expected at Phillips Bay or in eastern reaches of the Alaska coast beyond the summer range of juveniles overwintering in the Colville or Sagavanirktok deltas.

As one approaches the Colville River, one might expect fish of this size to become more common and, in fact, this probably does occur although it is not always reflected in trapnet catches (Craig and Haldorson 1981; Gallaway et al. 1982; Cannon et al. 1987; Glass et al. 1987). Many factors, including those related to year class strength in the Mackenzie River, the level of annual recruitment of young into Alaskan waters, and overwintering success may be responsible. Rough population estimates suggest considerable between-year variability in the number of intermediate-sized Arctic cisco occupying coastal areas near Prudhoe Bay (Moulton et al. 1985).

Not all young-of-the-year Arctic cisco produced within the Mackenzie River system migrate into Alaskan waters for rearing. Many are known to migrate instead eastward along the Tuktoyaktuk Peninsula (Jones and den Beste 1977; Bond 1982; Lawrence et al. 1984). That being the case, intermediate-sized fish should also be found in Canadian waters. It is clear from previous studies (Hatfield et al. 1972; Stein et al. 1973b; Percy 1975; de Graaf and Machniak 1977) that individuals of this size range are not common within the Mackenzie Delta itself during the summer. If they do migrate along the Yukon coast, it is clear from the present study that their migration does not extend as far as Phillips Bay. Kendel et al. (1975) captured few while sampling at numerous coastal sites between the Mackenzie and Herschel Island.

On the other hand, intermediate-sized Arctic cisco have been captured consistently in coastal waters of the Tuktoyaktuk Peninsula. (Galbraith and Hunter 1975; Jones and den Beste 1977; Byers and Kashino 1980; Bond 1982; Hopky and Ratynski 1983; Lawrence et al. 1984). No detailed study of their seasonal movements has been done; however, they do not appear to disperse as far to the east as do the larger fish (Lawrence et al. 1984) and there is evidence to indicate that they return to the delta earlier following the summer feeding period (Bond 1982).

Least cisco

Abundance and catch-per-unit-effort: Large (50.3%) and small (49.7%) least cisco were equally represented in our trapnet catches. As was the case for Arctic cisco, large least cisco were more likely to be captured on the seaward side of Niakolik Point as 66.0% of the total were taken in that trap (Table 6). CPUE in the seaward trap exceeded that in the protected side trap by 4.48 to 1.92 (Table 7).

Large least cisco were already common in Phillips Bay on 23 June when sampling began (Fig. 15, Tables A5.3 and A6.3). After peaking in cycles 2 (6.89) and 3 (7.10), CPUE began to decrease, reaching 0.92 in cycle 8 (10-16 August) and persisting at a low level for the duration of the sampling period (Fig. 15 and 16). Of the total catch, 66.4% were taken between 29 June and 26 July (cycles 2-5), while 89.4% were captured prior to 6 August. Over the final five weeks of sampling, CPUE averaged only

0.60 fish per trap-hour. The observed pattern of abundance for large least cisco was similar to that suggested by our 1985 gillnetting data (Bond and Erickson 1987).

In 1985, small least cisco were captured only sporadically and in small numbers along the Phillips Bay coast (Bond and Erickson 1987). Our 1986 results showed them to be much more common as they accounted for almost half the total trapnet catch for this species. Again, however, their appearance tended to be somewhat sporadic (Fig. 17; Tables A5.4 and A6.4) with 36.6% of the catch being recorded on six days (21 and 24 July, 7, 9, 15, and 16 August).

Small least cisco were virtually absent from Phillips Bay early in the study, yielding a CPUE of only 0.71 over the first four weeks. Young cisco (mainly <150 mm) began entering the study area in late July, resulting in a sharp increase in CPUE. Large catches on a few days produced abundance peaks in cycle 5 (6.02) and cycle 7 (7.78). After mid-August, CPUE returned again to low levels. Of the total overall catch of small least cisco, the great majority (81.1%) were trapped between 20 July and 23 August; i.e., during cycles 5 to 9 inclusive (Fig. 18).

Length-frequency distribution: Fork lengths for 7 073 measured least cisco are presented according to codend trap and by sampling period in Tables A7.4 to A7.6. These measurements have been applied to our total counts in order to produce time series and overall length-frequency descriptions of the migrant population.

Least cisco taken in the trapnets ranged in fork length from 37 to 390 mm, demonstrating a strongly bi-modal length-frequency distribution (Fig. 19). Most fish were either in the 270-329 mm range (43.6%) or between 80 and 149 mm (33.8%). Among least cisco classified as large (>250 mm) or small (<250 mm), fish in these size ranges accounted for 86.7% and 67.9%, respectively.

Fish in the larger of the two modes represent the portion of the least cisco population sampled in 1985 when 66.4% of the gillnet catch was between 275 and 324 mm in fork length (Bond and Erickson 1987). Our 1985 results suggest that the majority of these fish were from 7 to 9 years of age. Many were likely immature fish or mature non-spawners; however, in 1985, 11% of males and 19% of females were considered current year spawners.

Least cisco in the smaller mode are primarily age 1+ individuals with smaller numbers of age 2+ fish. This cohort was poorly represented in seine catches both in 1985 (Bond and Erickson 1987) and in 1986 (Table 6).

The length-frequency distribution of least cisco entering the trapnets changed over the course of the summer (Fig. 20). Overall, several size modes are apparent. Larger fish (primarily 270-329 mm) dominated the early season catches in the virtual absence of small individuals. With the arrival of small least cisco in late July, however, and with the decline in their own absolute abundance (Fig. 16), large least cisco represented a relatively small percentage of the total catch during the last six weeks of the study.

Small least cisco had their greatest abundance during cycles 5-9 (Fig. 18). They continued to dominate trapnet catches during the latter part of the summer in percentage terms despite their reduced CPUE. As indicated in Fig. 20, the first small fish to arrive in the study area were primarily individuals in the 79-109 mm range (age 1+). This age group dominated catches over the last seven weeks of the study and by the end of the summer, their modal size had shifted to the 110-139 mm range. A second, less obvious mode occurring around 150-169 mm, probably consists mainly of age 2+ fish.

Young-of-the-year least cisco were not common in Phillips Bay during 1985 (Bond and Erickson 1987) and few were captured in 1986. Only five members of this year class (43-62 mm) were taken in seines during the second year of the study, the first being captured on 2 August. Their presence in Phillips Bay at the end at August and in early September is indicated in Fig. 20 by a small mode occurring at the 60-69 mm length interval.

Unlike Arctic cisco, young-of-the-year least cisco apparently do not migrate far from the mouth of the Mackenzie River. They are most common in coastal habitats within the Mackenzie estuary (Kendel et al. 1975; Percy 1975; Bond 1982; Lawrence et al. 1984) and are known to enter tundra lakes on the Tuktoyaktuk Peninsula (Bond and Erickson 1985).

Recapture of marked fish: No Floy tags were applied to least cisco in 1986, but approximately 1 500 large individuals were marked by finclipping during the first ten days of the trapnetting operation. Only nine marked fish were recovered during the study, a recovery rate of just 0.6% (Table A8). Two of these were recaptured in June, shortly after their release. The other seven fish were recaptured between 24 July and 7 August, having spent approximately 3-5 weeks at large.

Summary: At least two distinct forms of least cisco occur in the Mackenzie Delta-Beaufort Sea area (McPhail and Lindsey 1970; Lawrence et al. 1984). Those captured in the present study are assumed to be of the anadromous form which spawns in the lower Mackenzie River watershed (Stein et al. 1973b) and undertakes summer feeding migrations into coastal areas of the Mackenzie estuary (Mann 1974; Percy 1975; Kendel et al. 1975; Galbraith and Hunter 1975; Bond 1982; Lawrence et al. 1984). Lake systems of Richards Island and the Tuktoyaktuk Peninsula are utilized extensively as feeding and overwintering areas (Lawrence et al. 1984; Bond and Erickson 1985).

Large least cisco were common at Phillips Bay from late June until late July but were rarely encountered in trapnet catches after mid-August. The fact that few marked fish were recaptured in the days shortly following their re-

lease suggests that large least cisco were migrating actively and that their residency time in Phillips Bay was brief.

Large least cisco captured during the first few weeks of our study are believed to have been moving westward, away from the Mackenzie Delta. The westward limit of their dispersal, however, and the timing of their return migration is unclear. They are not believed to migrate as far along the coast as Arctic cisco, nor much beyond Herschel Island. Previous studies (Kendel et al. 1975; Griffiths et al. 1975; Baker 1985) have shown that their abundance decreases quickly to the west of Phillips Bay. They are rarely encountered in coastal waters of the central Beaufort Sea (Griffiths et al. 1977; West and Wiswar 1986).

The pattern of CPUE for large least cisco (Fig. 15 and 16) suggests either that they did not go much beyond Phillips Bay in their westward migration and had begun to return to the Mackenzie by late July, or that the main body of the migration remained west of Phillips Bay throughout the summer and fish did not return to the delta until well into September. We feel that the former scenario is more likely. For example, Kendel et al. (1975) described an apparent eastward movement of least cisco along the Yukon coast during August while catches at Tuktoyaktuk have been observed to increase sharply in late August as fish began to return from summer feeding areas located east of the Mackenzie (Byers and Kashino 1980; Bond 1982). The recapture of seven of our marked least cisco between 24 July and 7 August also suggests an early return toward the Mackenzie Delta.

Young-of-the-year least cisco are abundant in the Mackenzie Delta and near the river mouth (Percy 1975; Lawrence et al. 1984; E. Jessop, pers. comm.). They have been reported entering Tuktoyaktuk Harbour in late July (Bond 1982) and are known to utilize some peninsula lake systems near Tuktoyaktuk for feeding and overwintering (Bond and Erickson 1985). Their distribution in coastal habitats, however, appears to be limited, and they do not appear to utilize lake systems located east of Tuktoyaktuk (K. Chang-Kue, pers. comm.). On the Yukon coast, young-of-the-year least cisco have been reported from as far west as Stokes Point (Kendel et al. 1975; Bond and Erickson 1987) but only in small numbers. Again in 1986, few young-of-the-year least cisco were taken in Phillips Bay. Although small least cisco were common in Phillips Bay in mid-summer, these were predominantly yearlings and two-year-olds.

The under-representation in our trapnet catches of least cisco in the 150-249 mm size range is interesting. Fish of this size (age 3-5) were also poorly represented in migrations in Freshwater Creek on the Tuktoyaktuk Peninsula (Bond and Erickson 1985). They were the dominant size group reported from Tuktoyaktuk Harbour in 1981, however, when sampling was done using Beamish trapnets, otter trawls, and variable mesh gillnets (Hopky and Ratynski 1983).

Other anadromous coregonids

The Mackenzie River supports large populations of five coregonid species. In many respects these species share a common generalized life history pattern, involving fall spawning, a long incubation period, and a complex series of migrations that provide a functional link between several spatially separated habitats. Many interspecific differences occur, however. A discussion of these similarities and differences is provided by Reist and Bond (1989).

One of the most obvious differences between these species lies in the degree of anadromy that they exhibit and the range of coastal habitats that they occupy. The following three species, broad whitefish, lake whitefish, and inconnu are not abundant along the Yukon coast and were captured in relatively small numbers in Phillips Bay during this study. They are discussed below as key species, however, because of the major role they play in the overall Mackenzie Delta-Beaufort Sea fish community.

Broad whitefish: Broad whitefish are abundant in the lower Mackenzie River and contribute substantially to the subsistence harvest of Mackenzie Delta communities. While anadromy plays an important role in their life history pattern, the occurrence of broad whitefish in coastal habitats appears to be concentrated to the east of the Mackenzie where the freshening influence of the river is greatest. Large numbers of broad whitefish utilize this freshened zone in moving between the delta and the shallow lake systems of Richards Island and the Tuktoyaktuk Peninsula (Percy 1975; Bond 1982; Lawrence et al. 1984; Bond and Erickson 1985). Relatively small numbers of broad whitefish have been reported from Yukon coastal waters west of the Mackenzie where more highly variable salinity regimes prevail, and where the under-ice environment approaches marine conditions (Mann 1974; Kendel et al. 1975; Griffiths et al. 1975; Baker 1985).

Only 14 broad whitefish were captured in Phillips Bay during the first year of the present study (Bond and Erickson 1987). None was captured in gillnets or small mesh seines in 1986, but 937 were taken in trapnets, representing 0.7% of the total catch in that gear and 1.3% of all anadromous coregonids (Table 5).

The numbers of broad whitefish captured daily in individual codend traps are given in Table A5.5. Considering the total combined catch from all codend traps it is apparent that, while present in Phillips Bay throughout the summer, broad whitefish were generally not abundant and CPUE values rarely exceeded 0.3 (Fig. 21a). The obvious exception occurred during cycle 6 (Fig. 22) when a sharp increase in CPUE was produced by the arrival of a group of small fish (<75 mm). Of all broad whitefish captured during the summer, 508 (54.2%) were taken in cycle 6 and within that week, 90.7% of the catch consisted of individuals smaller than 75 mm. Following the abundance peak of 27-29 July, small broad whitefish continued to be captured in Phillips Bay until the end of the study period (8 September) but only in small numbers.

Broad whitefish ranged in fork length from 35 to 595 mm but most were either small juveniles or large adults (Table 15, Fig. 23). Fish in the 150-449 mm size range accounted for just 10.9% of the total.

Individuals larger than 449 mm (n=112) are considered to be probable spawners. Representatives of this cohort were scarce in Phillips Bay prior to cycle 3 (6-12 July) and few were captured after the end of July. It is likely that their appearance in and subsequent departure from the study area represents an early season foraging migration followed by a return to the Mackenzie River in August to join the spawning population.

Gonadosomatic indices were determined for 16 broad whitefish during this study, 11 of which were captured in 1985 (Bond and Erickson 1987). Among mature females (n=9; 440-595 mm), GSI values ranged from 4.34 to 9.69, consistent with the range of values usually observed for female spawners in the southern Beaufort Sea area during the early summer (Bond and Erickson 1985). Mature males (n=5; 462-532 mm) had GSI values between 1.15 and 1.79.

Small broad whitefish were not captured in Phillips Bay during 1985, but fish less than 150 mm accounted for 77.2% of the total trapnet catch in 1986 (Table 15, Fig. 23). By far the majority of these (85.8%) were in the 50-74 mm size range and are presumed to be young-of-the-year. On the Tuktoyaktuk Peninsula many broad whitefish of this size enter tundra lake systems in which they may continue to reside for up to four years (Bond and Erickson 1985). In those systems the upstream migration from the Beaufort coast begins in late July. Although small numbers of juvenile broad whitefish have been reported upstream in the Blow River, which enters the Beaufort Sea east of Shingle Point (Fig. 1) (Steigenberger et al. 1975), this species is not known to utilize the mountain streams of the Yukon or eastern Alaskan coast.

The distribution of broad whitefish in coastal habitats is thought to be strongly influenced by salinity and they are usually found in greatest abundance near their river of origin (Furniss 1975; Griffiths et al. 1983; Moulton et al. 1985). Sixty-six percent of the small broad whitefish (<75mm) captured in Phillips Bay were taken on the inside of Niakolik Point where water tended to be warmer and less saline (Fig. 7 and 8; Tables A.1 and A.2). This was particularly evident during cycle 6 when 461 (73% of all small broad whitefish) were captured. Of this number, 357 (77%) were captured on the inside of the spit. The sharp increase in CPUE for small broad whitefish on 27-29 July coincided with a period of increased Babbage River flow (Fig. 3), decreased salinity on the inside of the spit (Fig. 8), and large cross-spit salinity differences. This rapid increase may or may not indicate an attempt by small broad whitefish to escape an area of high salinity; other factors may have been involved. However, small broad whitefish have been reported to move out of Prudhoe Bay into river mouths to avoid high salinity levels within the bay (W. Griffiths, LGL Ltd., pers. comm.).

In contrast to the small fish, most large broad whitefish tended to remain on the outside of Niakolik Point. Among those larger than 400 mm, 92% were captured in the dual trap (Table 15). As mentioned previously, most fish of this size were captured prior to the end of July.

Lake whitefish: Although considered anadromous, lake whitefish of the southeastern Beaufort Sea seldom migrate far from the mouth of the Mackenzie River (Lawrence et al. 1984). The least migratory members of the population appear to be those younger than age 4 or less than 225 mm in fork length which remain closely associated with the Mackenzie Delta (Bond and Erickson 1985). Previous studies along the Yukon coast have reported capturing lake whitefish only in small numbers (Kendel et al. 1975; Baker 1985). Only 17 specimens were taken in Phillips Bay during the first year of the current study (Bond and Erickson 1987).

In 1986, lake whitefish accounted for 0.3% of the total trapnet catch and 0.6% of anadromous coregonids (Table 5). None was captured in seines or gillnets. A small run entered Phillips Bay during cycle 3 but had apparently left the area by the end of cycle 4 (19 July) (Fig. 21b and 24). Of the total catch (n=417), 62.4% were taken between 8 and 17 July, during which time CPUE averaged 0.65 and ranged from 0.27 to 1.38 (Fig. 21b). The biggest daily catch (n=66) was recorded on 9 July and was largely responsible for raising the overall CPUE for cycle 3 to 0.74 fish per hour. Daily catches of lake whitefish from each codend trap are summarized in Table A5.6.

Lake whitefish from Phillips Bay ranged in fork length from 58 to 467 mm. The modal length interval was 300-324 mm and 80.1% of those measured (n=396) were between 250 and 374 mm (Table 16, Fig. 25), a situation almost identical to that observed during migrations in Freshwater Creek on the Tuktoyaktuk Peninsula (Bond and Erickson 1985).

On the basis of their length-frequency distribution it seems likely that most of the lake whitefish captured in Phillips Bay were non-spawners. Among lake whitefish in this region, sexual maturity may occur at fork lengths of 350 mm or less; however, most Mackenzie River spawners exceed 400 mm (Stein et al. 1973b; K. Chang-Kue, pers. comm.). We examined the gonads of only 19 lake whitefish (155-438 mm) during the two years of the current study. None of these was considered capable of spawning in the approaching spawning season.

Inconnu: Inconnu are an important part of subsistence fisheries in the Mackenzie Delta and throughout the Mackenzie River. Although found in coastal habitats, they tend to remain near the Mackenzie Delta and their coastal distribution in the southern Beaufort Sea is largely restricted to the area between Shingle Point and Tuktoyaktuk Harbour (Kendel et al. 1975; Percy 1975; Galbraith and Hunter 1975; Bond 1982; Lawrence et al. 1984). These and other authors have reported that most inconnu found in estuarine habitats during the summer are non-spawn-

ing individuals. During 1985, 20 inconnu were captured at Phillips Bay, none of which was sexually mature (Bond and Erickson 1987).

Only 109 inconnu were taken in Phillips Bay during 1986, accounting for just 0.1% of the total trapnet catch (Table 5). The majority (45%) were taken between 13 and 19 July with the largest daily catch (n=15) occurring on 16 July. Apart from cycle 4, when the overall CPUE reached 0.15, inconnu were captured only sporadically throughout the summer (Fig. 21c and 26). A slight rise in CPUE in early September was attributable to the movement into the study area of a number of small individuals (<125 mm). Inconnu were not captured in gillnets or seines during 1986.

Fork lengths of inconnu captured in trapnets varied from 56 to 720 mm but most were either larger than 425 mm (70.6%) or smaller than 125 mm (25.7%) (Table 17; Fig. 27). Members of the larger group were common only during cycle 4 (13-19 July); of all large inconnu taken during the study (n=77), 47 (61.0%) were captured that week.

Small inconnu first appeared in the trapnets on 21 July (n=2; 62-114 mm) and fish of this smaller size group outnumbered large inconnu in our catch through the remainder of the summer. This was particularly so in early September when they accounted for 84.2% of the inconnu catch. Although none of these small inconnu was aged, at least the smaller members of the group are assumed to be young-of-the-year (0+). A single member of this age group (51 mm) was taken in seines during our 1985 study (Bond and Erickson 1987).

The movements and habitat utilization patterns of young-of-the-year inconnu within the lower Mackenzie River are unknown. The capture of such young fish has seldom been reported either within the delta (Percy 1975; de Graaf and Machniak 1977) or along the Beaufort coast (Kendel et al. 1975; Galbraith and Hunter 1975; Jones and den Beste 1977; Hopky and Ratynski 1983; Bond 1982; Lawrence et al. 1984; Bond and Erickson 1987). The results of the present study suggest that coastal habitats may be utilized by young inconnu more commonly than previously suspected.

Arctic charr

Arctic charr of the western Arctic occur as lake-resident, stream-resident, and anadromous populations, of which the latter are the most important. McCart (1980) provides an excellent review of the literature describing the distribution and biology of charr in Beaufort Sea drainages.

Anadromous populations are found in mountain streams between the Babbage River and Alaska's Sagavanirktok River where the occurrence of perennial groundwater sources provides essential spawning and overwintering habitat. As the name implies, these populations include a migratory component which undertakes an annual seaward migration to feed. During the summer at sea, these fish may move considerable distances, but tend to remain near shore. Recent evidence suggests that different coastal rivers host anadromous charr which, while they may intermingle freely during their summer coastal migrations, represent distinctly different and genetically identifiable stocks which do not interbreed (R.W. Marshall, U.S. Fish and Wildlife Service, 1011 East Tudor Rd., Anchorage, AK 99503, pers. comm.). On the Yukon coast, anadromous charr are known to occur only in the Firth and Babbage rivers. Those captured during the present study are presumed to be members of the Babbage River population described by Bain (1974).

Abundance and catch-per-unit-effort: Trapnet results demonstrate that Arctic charr were considerably more abundant in Phillips Bay than was suggested by our 1985 study (Bond and Erickson 1987). Even so, the 1 676 charr counted represented only 2.0% of all anadromous fish taken (Table 5). Although more were taken in the single trap (54.2%) than on the seaward side of Niakolik Point (Table 6), overall CPUE was identical (0.50) at the two locations (Table 7). Gillnets captured only a single Arctic charr in 1986 (Table 8) while three were taken in seines (Table 9).

Details of daily charr catches by codend trap are provided in Table A5.7 while daily and weekly abundance patterns observed over the course of the summer are shown in Fig. 28 and 29, respectively. The highest CPUE values of the summer were recorded during the first two weeks of sampling (1.50 and 1.45) but abundance declined sharply after 5 July. After fluctuating between 0.07 and 0.48 fish per trap-hour from cycle 3 to cycle 9 (6 July-23 August), the weekly CPUE rose rapidly to 1.33 during the last week of August (cycle 10), then dropped to low levels in early September (Fig. 29). Between these two major abundance peaks a smaller one occurred. This smaller peak, which appeared in late July and early August (cycles 6 and 7), is apparent in the overall weekly plots (Fig. 29) but is more noticeable in the daily CPUE plots for the dual trap. It was not observed at the single trap on the inside of Niakolik Point (Fig. 28).

Length-frequency distribution: Fork lengths of trapnetted Arctic charr ranged from 33 to 634 mm, the majority (66.0%) falling within the 125-274 mm range (Fig. 30). Large fish, between 375 and 549 mm, accounted for 24.2% of the total sample. Within the group of small fish two distinct modes can be seen; one occurring at the 150-174 mm length interval and the other at 225-249 mm.

The length-frequency distribution of charr taken in the trapnets varied over the course of the summer (Table 18, Fig. 31). These data indicate that the early season abundance peak (Fig. 28 and 29) was dominated by small fish with a modal length of 150-174 mm. Of all fish taken during the first two weeks of sampling (n=667), fish in this length interval accounted for 39.1% and those between 125 and 199 mm made up 63.9%. During the same two-week period, large charr (375-549 mm) accounted for 23.2% of

the total catch. Large charr were considerably less abundant during cycle 2 than cycle 1, however, as their contribution to the total charr catch decreased from 28.9% to 16.8%. By cycle 3 (6-12 July) the abundance of all charr had decreased substantially but most of those taken during week 3 were small individuals.

The late summer abundance peak observed in the latter part of August (cycle 10) also featured a predominance of small fish, although on this occasion the modal length occurred at the 225-249 mm interval and 73.9% of all charr captured during the week were between 225 and 274 mm in fork length. Large fish accounted for just 4.0% of all charr taken during cycle 10, and none was captured subsequent to 30 August.

In contrast to the early and late summer abundance peaks, the small peak observed during mid-summer (27 July-9 August) consisted primarily of large fish which accounted for 91.5% of the charr taken during cycles 6 and 7.

Age and maturity: Arctic charr on the Beaufort coast emerge in May or June at lengths ranging from 19-27 mm (McCart 1980). Their pattern of early growth depends greatly upon the age at which they make their first seaward migration. This may occur as early as age 1 (second summer) or as late as age 5, but most commonly at age 3 or 4 (Yoshihara 1973). Slow growth in fresh water is followed by very rapid growth during the summer of smolting.

At Phillips Bay, the small fish captured in trapnets during the early weeks of our study (modal length 150-174 mm) are believed to be first time migrants. Age determinations performed on a small number of individuals from these early trapnet catches showed most to be age 3 (age 2=1; age 3=9; age 4=1). The return migration of these fish to the Babbage is thought to be represented in Fig. 30 by the mode occurring at the 225-249 mm length interval. That a time interval separates the two modes indicated for small charr in Fig. 30 is shown in Fig. 32, in which the weekly catches (Fig. 31) have been grouped into three time periods. The shift to the right, from a class mark of 162 mm to one of 237 mm can be considered to represent the summer growth of this cohort. Thus, it would appear that during their first summer at sea, Babbage River charr achieved an increase in fork length of approximately 46%. Assuming a feeding period of 60 days, this represents a growth rate of about 1.25 $mm \cdot d^{-1}$.

On the basis of the age-length relationship determined primarily from fish captured in 1985 (Table 19), most large charr taken in trapnets are assumed to belong to age groups 6-10 inclusive (maximum otolith age = 14 years). The youngest mature fish were six years of age. In 1985, the sex ratio for gillnetted charr was heavily in favour of females which comprised 72% of all fish for which sex was determined. The difference in sex ratio was most pronounced among mature individuals (n=27), where females comprised 81% of the total (Bond and Erickson 1987).

Recapture of marked fish: Floy tags were not applied to Arctic charr during this study, but approximately 500 individuals were marked by fin-clipping between 23 June and 3 July. Although 22 marked fish were recaptured, a recovery rate of about 4.4%, all but one had been recaptured by 4 July, thus providing no useful information on movement patterns or time spent at sea (Table A.8). The other recapture occurred on 25 August, the fish (226 mm) having been at large for at least 53 days. This individual is assumed to have been returning to the Babbage River at the time of its recapture.

Summary: Arctic charr captured in this study are assumed to be members of the Babbage River population. The observed CPUE and length-frequency data indicate the classic migratory behaviour for this species between the home river and adjacent coastal waters. The seaward migration begins at or shortly after break-up and was apparently still in progress at the commencement of our study. Large charr had left the vicinity of Phillips Bay by late June while the out-migration of smolts continued until about mid-July.

Large charr had begun to return to the Babbage River by late July while the return migration of smolts began about mid-August and peaked during the last week of that month. Most charr had left coastal waters by September. It would appear, therefore, that the summer feeding period for Babbage River charr is approximately 50 to 60 days in length.

Otolith ages for Arctic charr ranged up to 14 years, the youngest mature individuals being age 6 (Table 19). By inference from the age-length relationship, most of the large charr taken in trapnets were 6 to 10 years old.

Most Babbage River charr appear to smolt at age 3. This differs from the results of Bain (1974), who found that 43% of first time migrants were age 2, but is similar to the situation in the Sagavanirktok River, Alaska, where charr did not move seaward before age 3 (Yoshihara 1973).

Arctic charr appear to achieve a rapid rate of growth during their first year at sea. Our data suggest that this rate approximates 1.25 $mm \cdot d^{-1}$ for an overall increase of 46% in fork length.

The distributional pattern for Babbage River charr while at sea is unknown. During this period, however, they feed heavily on fish and Amphipoda. A detailed analysis of 26 stomachs of charr captured in Phillips Bay during 1985 showed fish to have a frequency of occurrence of 69% and to comprise 47% of the wet weight food biomass. Fish species identified in the food included rainbow smelt, fourhorn sculpin, Arctic cod, least cisco, ninespine stickleback, and Arctic lamprey. Amphipoda appeared in 77% of the stomachs accounting for 29% of the food in terms of wet weight (Bond and Erickson 1987).

Rainbow smelt

Unlike the anadromous coregonids and Arctic charr, rainbow smelt spawn in the spring and overwinter in the sea. They are widely distributed in Beaufort coastal waters but usually account for less than 1% of total summer catches (Griffiths et al. 1975, 1977; Griffiths and Gallaway 1982; Griffiths et al. 1983; Wiswar and West 1986; Cannon et al. 1987). They seem to be somewhat more abundant near the Mackenzie and Colville rivers in which spawning is believed to occur (Moulton and Carpenter 1986; Percy 1975; Byers and Kashino 1980; Bond 1982; Lawrence et al. 1984). On the Yukon coast, Kendel et al. (1975) captured smelt as far west as Herschel Island, but reported them to be abundant only at Phillips Bay. Baker (1985) found smelt to be common along the eastern side of Herschel Island and assumed them to be of Mackenzie River origin.

During the first year of the present study, rainbow smelt accounted for 4.3% and 2.7% of the total catch in gillnets and seines, respectively. They were the only species to be captured at all sampling locations (Bond and Erickson 1987).

Rainbow smelt were captured throughout the summer at Phillips Bay in 1986, accounting for 5.5% of the total trapnet catch and 9.4% of all anadromous fish taken (Table 5). Only five individuals were taken in gillnets (Table 8), but smelt occurred at all seining locations, contributing 5.4% of the total catch in that gear (Table 9).

Daily catch data and the corresponding CPUE values for rainbow smelt are shown in Tables A5.8 and A6.6, respectively. Smelt tended to be more abundant on the outside of Niakolik Point as 71.9% were captured in the dual trap (Table 6). Overall CPUE was 3.75 at the seaward location compared to 1.22 on the inside of the spit. The combined overall CPUE for rainbow smelt during the study was 2.37 fish per trap-hour (Table 7).

Figures 33 and 34 illustrate the observed daily and seasonal fluctuations, respectively, in rainbow smelt CPUE. Considering the combined catch from all codend traps, the overall CPUE was usually less than 5.00, exceeding that value on only five days during the summer. The highest values were recorded during cycle 5 (3.63) and cycle 6 (4.84) as a result of large daily catches on 23 July (n=486) and 30 July (n=353).

Rainbow smelt taken at Phillips Bay in 1986 varied in fork length from 14 to 350 mm. Trapnets took smelt over the range 50-350 mm with most individuals (63.0%) being between 240 and 279 mm (Table 20, Fig. 35). Fish of this size dominated trapnet catches throughout the summer, contributing between 40.3 and 77.1% of the catch within sampling periods (Table 21). Fish smaller than 200 mm fork length accounted for 20.4% of smelt in the trapnet catches. During the previous summer, by contrast, gillnets captured only one smelt under 200 mm and 77% of the total catch consisted of individuals in the 225-274 mm range (Bond and Erickson 1987). Among smelt captured in seines, 98.3% were less than 50 mm in length (Table 13).

Rainbow smelt from Phillips Bay were found to range in age from 0 to 17 years (Table 22). Although trapnets took specimens as young as age 2, it is clear, by inference from the length-frequency distribution (Fig. 35), that the majority of smelt captured in that gear were 8 to 10 years old.

Based on our 1985 observations (Bond and Erickson 1987), these large fish represent the spawning segment of the population. In the first year of this study, most of the smelt examined from gillnet catches were sexually mature, including 99% of the males (n=73) and 71% of the females (n=58). Within the Beaufort Sea area, rainbow smelt are reported to reach first maturity between age 5 and 7 (Stein et al. 1973b; Craig and Haldorson 1981).

Currently, rainbow smelt in the Canadian Beaufort are believed to spawn only within the Mackenzie River system. Spawning occurs just prior to spring break-up and the spent adults then leave the river to forage in coastal waters. Smelt fry, following their emergence, are carried into the Mackenzie estuary on the spring flood. At hatching, young smelt are approximately 5 mm in length (McKenzie 1964). Ratynski (1983) reported a mean length of 12.4 mm on 11 July in Tuktoyaktuk Harbour. In 1985, young-of-the-year were first captured in Phillips Bay on 23 July, at which time lengths ranged from 10 to 19 mm with a mean of 14.4 mm (Bond and Erickson 1987; Table 22). During the second year of the current study, young-of-the-year smelt did not appear in seine hauls until 2 August, when 10 fry (mean length 19.5 mm; range 18-21 mm) were collected at Site 2 (Fig. 2). The timing of their first arrival in our study area (late July-early August) suggests that smelt fry originated outside the study area and were carried into Phillips Bay by coastal currents. The possibility exists, however, that spawning occurs either in the Babbage or Spring rivers or in coastal habitats freshened by floodwaters from these streams. Small rainbow smelt captured on 22 June 1986 had a mean total length of 37 mm (range 31-42 mm) and were assumed to be 1-year-old fish (Table 22).

Regardless of whether or not rainbow smelt spawn within the study area, it is clear that Phillips Bay is an important feeding and nursery area for this species. During 1985, the diet of smelt captured in Phillips Bay was dominated by fish, which comprised 78% of the total food biomass. Arctic cod was found to be the primary food item and was estimated to account for a minimum of 49% of the total diet. Other fish species identified from smelt stomach contents included fourhorn sculpin, Arctic cisco, rainbow smelt, and eelpout. Mysidacea occurred in 77% of the stomachs examined in the laboratory and accounted for 18% of the food biomass. Rainbow smelt captured in Phillips Bay had been feeding actively as only 15% of the stomachs examined (n=94) were empty (Bond and Erickson 1987).

Arctic flounder

The Arctic flounder has a circumpolar distribution in brackish nearshore areas and is common in catches from the Beaufort Sea coast. During a three-year survey of coastal habitats in the southeastern Beaufort, this species accounted for 19.3% of the total gillnet catch (Lawrence et al. 1984). Most coastal studies, however, whether sampling with gillnets or trapnets, have reported taking Arctic flounder in relatively small numbers (Percy 1975; Kendel et al. 1975; Griffiths et al. 1975, 1977; Bond 1982; Baker 1985; Moulton et al. 1985; Cannon et al. 1987). Although it accounted for 14% of all marine fish, Arctic flounder made up only 5.9% and 1.6% of the total catch in gillnets and seines, respectively, during our 1985 study of Phillips Bay. It was noted at that time that flounder were more common near the shoreline than at offshore sites and that abundance was greatest at sites located close to the Babbage River (Bond and Erickson 1987).

The results of the 1986 trapnetting study suggest that Phillips Bay provides much more important summer habitat for Arctic flounder than previously suspected. Arctic flounder made up 31.5% of the total trapnet catch in 1986 (second in abundance to Arctic cisco) and accounted for 77.3% of all marine fish taken (Table 5). Its abundance, as revealed by the trapnet data, could not have been predicted on the basis of gillnet (n=4) or seine (n=96) catches (Tables 8 and 9).

Daily catches of Arctic flounder by codend trap and the corresponding CPUE values are presented in Tables A5.9 and A6.7, respectively. Total daily catches exceeded 1 000 fish on 11 occasions during the summer, the highest counts occurring on 17 and 18 July (n= 2 537 and 2 714). As was the case for the other marine species, the largest catches of flounder occurred on the seaward side of Niakolik Point, 69.6% of the total being taken in the dual trap (Table 6). Overall CPUE was 20.65 at the dual trap compared with 7.51 on the inside of the point (Table 7).

Considering the total combined catch, the overall CPUE for the study was 13.49 (Table 7). CPUE fluctuated greatly from day to day, particularly in early summer and particularly in the double trap where values of 140.80 and 146.45 were recorded on 30 June and 2 July, respectively (Fig. 36). Arctic flounder abundance was greatest in cycles 2, 3, and 4 (29 June-19 July), during which time the overall CPUE was 29.06. Of the total summer catch, 58.9% was taken by the end of cycle 4 and 71.7% by the end of cycle 5 (26 July). Following the strong abundance peak of cycle 4, CPUE dropped sharply to reach 5.61 in cycle 6. It recovered to 10.91 in cycle 7, but then declined slowly over the remainder of the summer, averaging only 3.06 from 24 August to 8 September (Fig. 37).

The extent to which Arctic flounder undertake longshore coastal movements in the Beaufort Sea area is not known. Such movements are likely minor, however, with onshore-offshore movements being more typical. The pattern observed at Phillips Bay suggests an early summer movement into nearshore areas and a later return to deeper offshore waters for overwintering. A similar pattern has been observed in Tuktoyaktuk Harbour where Arctic flounder were assumed to move into deeper water within the harbour in late summer (Bond 1982).

Although food habits of Arctic flounder were not assessed in detail during this study, it is assumed that their abundance in late June and early July was related to feeding. High CPUE values during that period occurred at a time when nearshore areas teemed with enormous numbers of the isopod Mesidotea entomon which were in the process of shedding their young. This isopod is a common component of the diet of many fish species along the Beaufort coast.

Apart from the first few days, when most fish were measured, lengths were recorded for only 10 Arctic flounder per day. This is a small sample relative to the number of fish usually captured and may not be fully representative of the total catch. Because the single trap was usually checked first, the measured sample was usually obtained from that trap.

Total lengths were determined for 1 169 trapnetted Arctic flounder. While ranging in length from 29 to 293 mm, the great majority (75.4%) were between 150 and 219 mm (Fig. 38). Similarly, those captured in seines (n=96) ranged from 31 to 272 mm with most (72.9%) falling in the 150-224 mm length range (Table 13). These results are similar to those obtained in 1985 when fish between 150 and 224 mm accounted for 69.2% of all Arctic flounder caught in Phillips Bay (Bond and Erickson 1987). Arctic flounder in Phillips Bay were larger than those reported from Beaufort Lagoon, Alaska where 70.3% of those captured were 101-150 mm long (Wiswar 1986), but smaller than those taken along the outer Mackenzie Delta and Tuktoyaktuk Peninsula where the modal size was 226-275 mm (Lawrence et al. 1984).

Otolith ages were determined for a small number (n=42) of Arctic flounder taken in 1985 in order to obtain some insight as to the probable age of flounder captured during the 1986 trapnet study. The maximum age observed in our sample was 15 years, but from the age-length relationship obtained (Table 23) it would appear that the majority of flounder captured in Phillips Bay during 1986 were 6- to 9-year-old fish. The smallest individuals captured (29-31 mm) were assumed to be age 1+.

No young-of-the-year Arctic flounder were captured in Phillips Bay although 25% of males and 38% of females were found to be sexually mature during the 1985 study (Bond and Erickson 1987). The youngest mature flounder in our sample were an age 6 male (177 mm) and an age 7 female (193 mm). In Tuktoyaktuk Harbour, Arctic flounder spawn in mid-winter (Bond 1982) and the larvae emerge prior to ice-out. The young apparently complete their metamorphosis and assume a demersal life style by mid-summer (Ratynski 1983).

Fourhorn sculpin

The fourhorn sculpin has a circumpolar distribution in cold, brackish waters. It is a highly significant member of the ichthyofauna along the Beaufort coast where it is usually the most abundant marine fish taken and serves as forage for many species (Kendel et al. 1975; Percy 1975; Galbraith and Hunter 1975; Griffiths et al. 1975, 1977; Lawrence et al. 1984; Baker 1985; Cannon et al. 1987). During the first year of the present study it accounted for 9.3% of the total gillnet catch and 29.5% of all fish taken in seines. It was most abundant at nearshore locations where 94.2% of the gillnet catch was taken (Bond and Erickson 1987).

Fourhorn sculpin made up 7.4% of the trapnet catch at Phillips Bay during 1986, accounting for 18.1% of all marine fish taken in that gear (Table 5). Only two specimens were captured in gillnets (Table 8), but, as in 1985, sculpin were captured at all seining locations and comprised 50.5% of the total catch in small mesh seines (Table 9).

Daily catch data and the corresponding CPUE values for fourhorn sculpin by individual codend trap are shown in Tables A5.10 and A6.8 respectively, and are summarized in Tables 6 and 7. In general, trapnet catches remained remarkably consistent throughout the study period, and daily CPUE values tended to fluctuate in a narrow range around the overall study mean of 3.16 fish per trap-hour. The obvious exceptions occurred on 18-19 July when large catches in the double trap (n=973 and 1 357) resulted in high CPUE values for those days (Fig. 39) and in the weekly value for cycle 4 (Fig. 40). Ignoring the results on those two days, the overall trend seems to point to an increase in CPUE toward the end of June or in early July as sculpin reoccupied areas that had been frozen to the bottom during winter, followed by a gradual decline through the remainder of the summer (Fig. 40).

The onshore movement of fourhorn sculpin is well-timed, therefore, to take advantage of the high density of the isopod Mesidotea entomon mentioned earlier. This isopod is preyed upon by many fish species on the Beaufort coast but is particularly important to sculpins. It dominated the stomach contents of fourhorn sculpin captured during 1985. Among stomachs examined in the field that contained some food (n=166), 83% contained isopods. A more detailed laboratory examination of 25 sculpin stomachs revealed that all contained isopods, which comprised 81% of the total food biomass (Bond and Erickson 1987).

Total lengths of fourhorn sculpin at Phillips Bay in 1986 varied from 11 to 351 mm. Trapnets captured sculpin over a much wider size range than did gillnets during the first year of the study. During 1985, gillnetted fish ranged in length from 109 to 310 mm, but only one was shorter than 125 mm while most (87.4%) were between 150 and 249 mm (Bond and Erickson 1987). By contrast, trapnetted sculpin varied from 47 to 351 mm. Of the total sample (n=858), 14.1% were smaller than 100 mm, 61.8% were between 100 and 199 mm, and 91.3% fell in the 60-239 mm range (Fig. 41). Among sculpin captured in seines (11-275 mm), 84.9% were less than 25 mm in total length (Table 13).

Fourhorn sculpin appear to grow slowly and considerable overlap is evident in length ranges between age groups (Table 24). Maximum otolith age for Phillips Bay sculpin was 14 years, although by inference from the length-frequency distribution (Fig. 41), few exceeded age 10. The small mode occurring at a total length of 60-79 mm is thought to consist primarily of 2-year-old individuals. Although no otoliths were examined for fish of this size, a clue to their age can be obtained from the time series length-frequencies shown in Table 25. Young-of-the-year sculpin first appeared in the 10-14 mm range during the first week of sampling, and the growth of this cohort over the course of the summer is evident. By September, young sculpin appear to achieve a total length of 15-39 mm. The larger fish in Table 25 (40-99 mm) probably represent age groups 1 to 3.

On the Beaufort coast, fourhorn sculpin are reported to mature at age 2 to 6 with males tending to mature earlier than females (Griffiths et al. 1975, 1977; Jones and den Beste 1977; Craig and Haldorson 1981). At Phillips Bay, the youngest mature fish seen were age 6 for females and age 7 for males based on 1985 observations (Table 24). During 1985, females comprised 66% of all fourhorn sculpin for which sex was determined (n=300). Among females (n=198), 66% were sexually mature while, of 102 males examined, 43 (42%) were mature (Bond and Erickson 1987). Sex and maturity were not examined for our 1986 trapnet sample.

Fourhorn sculpin spawn in mid-winter (Westin 1968; Bond 1982). The eggs hatch before break-up and the young are found in coastal habitats the length of the Beaufort coast during the summer, often in large numbers (Kendel 1975; Percy 1975; Jones and den Beste 1977; Bond 1982; Lawrence et al. 1984; Bond and Erickson 1987).

Young-of-the-year sculpin dominated seine catches in both years of the present study. The earliest date of capture was 28 June 1986, on which day five individuals (mean length 12.8 mm; range 11-14 mm) were taken at Site 66 (Fig. ?). While taken at all seining locations, young-of-the-year sculpin were particularly abundant at Site 66 where 36% of all seined sculpin were captured during both years of the study (Bond and Erickson 1987; Table 9). Young sculpin achieved their greatest abundance in Phillips Bay between 22-28 July in 1985 (Bond and Erickson 1987) and in period 6 (27 July-2 August) in 1986 (Tables A4.1 to A4.10).

Saffron cod

The saffron cod has received little scientific attention in Canada and details of its life history are not well known. Spawning may occur in offshore waters, but also in deep coastal bays such as Tuktoyaktuk Harbour where ripe and spent fish have been captured in March (Bond 1982). Emergence likely occurs between

April and June (Morrow 1980). The young are planktonic and reach a length of 7.5 mm by mid-August (Ratynski 1983). A 34 mm cod reported as young-of-the-year by Jones and den Beste (1977) was presumed to be age 1+ by Ratynski (1983). Movement patterns of saffron cod have not been described, although these undoubtedly involve inshore-offshore movements between the estuarine coastal and offshore marine environments. This species is currently the subject of a Masters program being conducted by Mr. J. Johnson of the University of Manitoba Department of Zoology and based on specimens collected at Phillips Bay during the present study.

Previous gillnetting studies have suggested that saffon cod, while widely distributed, was not abundant in Beaufort coastal habitats (Riske 1960; Kendel et al. 1975; Griffiths et al. 1975; Lawrence et al. 1984; and others). Recent Alaskan trapnetting studies, however, have shown this species to be much more abundant than previously thought, although even in this less selective gear it seldom accounts for more than 1.5% of the total catch (Griffiths et al. 1987; Moulton et al. 1985; Cannon et al. 1987; Glass et al. 1987; Reub et al. 1988).

Only 22 saffron cod were taken in gillnets at Phillips Bay during the first year of the study (Bond and Erickson 1987). By contrast, 2 473 were captured in 1986 representing 1.7% of the total trapnet catch (Table 5). Seasonal summaries for total catch and CPUE are provided in Tables 6 and 7, respectively. These summaries are based on daily catch statistics and corresponding CPUE values presented in Tables A5.11 and A6.9.

Few saffron cod were captured during the first week of sampling but catches increased sharply during cycle 2 as cod moved into the area (Fig. 42 and 43). Initial large catches were made at the inside trap but after cycle 3 (12 July), the majority of cod were taken in the double trap. Overall, 40.9% of saffron cod were captured at the single trap while 59.1% were taken taken on the seaward side of Niakolik Point (Table 6). The large catches at the single trap during cyles 2 and 3 occurred at a time when ice conditions prevented full operation of the double trap. In terms of CPUE, values recorded overall at the dual trap (0.96) were almost double those observed on the inside of the point (0.56) (Table 7).

Saffron cod ranged in total length from 128 to 525 mm but the overall catch consisted of fish belonging to two distinct size groups (Fig. 44; Table 26). The length-frequency distribution varied over time, reflecting not only the growth of some individuals but also a difference in movement patterns by fish of different sizes.

The smaller group consisted primarily of individuals in the 200-299 mm range which accounted for 61.2% of the total trapnet sample. Within this group, a mode occurred at the 240-259 mm length interval. The position of this mode tended to shift from left to right over time (Table 27) as these fish grew. Members of this size group were the first saffron cod to enter the study area in 1986, and dominated trapnet catches over the first five weeks of sampling, contributing 78.2% of the total catch during that time. Their relative abundance decreased during cycles 6-8 (27 July - 16 August) as larger fish became more numerous, but increased again toward the end of the summer. They accounted for 87.8% of all saffron cod captured between 31 August and 8 September (Table 27).

The larger group of saffron cod was composed mainly of fish in the 380-439 mm size range with a mode occuring at the 400-419 mm interval (Fig. 44). These large fish apparently followed the small cod into the study area and departed earlier (Table 27). They dominated trapnet catches in mid-summer (27 July - 16 August), during which period they accounted for 65.6% of the total catch.

The nature of the gear is obviously critical in sampling saffron cod populations. This species is not sampled effectively with gillnets and most gillnetting studies have reported capturing few saffron cod less than 300 mm in length (Percy 1975; Jones and den Beste 1977; Bond 1982; Lawrence et al. 1984; Bond and Erickson 1987). On the other hand, small cod predominated in trapnet catches from Tuktoyaktuk Harbour (Hopky and Ratynski 1983). The reason for the paucity of cod in the 300-379 mm range at Phillips Bay is unclear, but suggests the occurrence of one or more year class failures.

SUMMARY

The fish fauna of the Beaufort Sea coast is dominated by a small number of marine and anadromous species whose relative abundance varies according to location and time of year. Marine species complete their entire life cycle within the Beaufort Sea. For some, such as Arctic flounder and fourhorn sculpin, brackish waters are important as feeding and nursery areas, and as overwintering and spawning habitat (M. Lawrence, pers. comm.). They occupy the coastal zone in early spring and move into deeper water for overwintering. Longitudinal migrations along the coast are not known to occur.

The anadromous species, on the other hand, spawn and overwinter either in fresh water or in the brackish waters of river deltas or deep coastal embayments. They enter coastal waters at spring break-up in search of food or to complete particular stages of their life histories. Because they are not as tolerant of marine conditions as are the marine forms, their migrations while "at sea" are restricted to the narrow band of brackish water which forms adjacent to the coastline during the summer period. For this reason, it is the anadromous forms that are likely to be most affected by any proliferation of shore-based support facilities within the nearshore zone.

That structures such as solid-fill gravel causeways can seriously alter local temperature-

salinity regimes has already been demonstrated by the Alaskan experience at Prudhoe Bay. How anadromous fish populations will be affected ultimately by these and future developments remains to be seen. In the meantime, it is essential that every effort be made to improve our understanding of the life history details for these important fish species. This study represents a contribution toward achieving that objective.

The fish community within Phillips Bay was studied from 29 June to 21 August 1985 and from 23 June to 8 September 1986. A survey-type approach was taken during the first year as fish were sampled by gillnets and seines at a number of locations between Kay Point and Stokes Point. This work permitted a preliminary description of the relative abundance, distribution, and movements of the major species and provided data relating to their length, weight, age, sex, maturity, condition, and food habits.

The 1986 effort focused on attempting to monitor the migratory patterns of the major fish species past a single location through the use of shorebased trapnets. Trapnets are considered superior to gillnets for sampling fish populations in Beaufort coastal waters because they are less selective as to size and species of fish, inflict less mortality, and can be deployed continuously. Of primary concern during 1986 were the anadromous fish, particularly the coregonids and Arctic charr, since these are the species of greatest importance to the local people.

Because different sampling methods and approaches were employed during the two summers, we have chosen to report the results separately, insofar as that was possible. Thus, the 1985 results are summarized in Bond and Erickson (1987) while the present report highlights the results of the 1986 trapnetting study. In interpreting the trapnet results, inferences drawn from the previous year's work proved useful. Certain information, collected in 1985 but not available for the earlier report, have been included in this document. The main findings of the study are summarized below:

1. Within Phillips Bay, summer water temperature and salinity depend strongly on discharge from the Babbage and Spring rivers and can change rapidly as a result of wind action. Typically, the warmest, freshest water is found nearshore and close to the mouth of the Babbage River. Offshore water tends to be colder and more saline than that at shoreline locations. Similarly, along the 5 m isobath, water is usually colder and more saline at the bottom than at the surface.

2. The summer fish community of Phillips Bay changes over time as a result of migratory activity, but consists largely of anadromous species (n=7) and marine-brackish water forms (n=8). Freshwater species (n=6) occurred in small numbers, accounting for just 0.1% of the total catch.

3. Trapnet catches were dominated by five species which together accounted for 95.9% of the total. These included Arctic cisco (37.1%), Arctic flounder (31.5%), least cisco (14.3%), fourhorn sculpin (7.4%), and rainbow smelt (5.5%).

4. Seven anadromous species contributed 59.2% of the total trapnet catch. Within this group, Arctic cisco was the most abundant (62.7%), followed by least cisco (24.4%), rainbow smelt (9.4%), Arctic charr (2.0%), broad whitefish (1.1%), lake whitefish (0.5%), and inconnu (0.1%). Apart from Arctic charr, which are believed to be members of the Babbage River population, anadromous fish captured in Phillips Bay during this study are thought to originate from the Mackenzie River.

5. Within Phillips Bay, fish tended to be more abundant at the shoreline than offshore. Of the anadromous species, Arctic cisco was the one most likely to venture out to the 5 m isobath, where it was captured both at the surface and at the bottom. Broad whitefish, lake whitefish, and inconnu were never captured at offshore locations.

6. Large Arctic cisco and large least cisco were already present in the study area by late June when sampling began. Mark-recapture evidence indicates that the residency period for individual fish within Phillips Bay was very short, suggesting active migration. The early summer phase of these migrations is believed to have been westward, away from the Mackenzie River. Large least cisco began to return to the Mackenzie earlier (late July) than large Arctic cisco (late August).

7. Most of the Arctic cisco captured in trapnets were small individuals, primarily young-of-the-year and yearlings. The migration of these small fish through the study area began in mid-July and peaked in early to mid-August. Substantial numbers of small Arctic cisco remained in Phillips Bay at the end of the sampling period.

8. The results of the present study are consistent with the requirements of the "single stock" hypothesis concerning the life history pattern of Arctic cisco in the southern Beaufort Sea (Gallaway et al. 1983).

9. About half the least cisco captured in trapnets were small individuals (<250 mm), but few young-of-the-year were taken. Small least cisco (age 1 and

2) began to enter Phillips Bay in late July and had apparently left the study area by late summer.

10. With the exception of a significant positive relationship for large least cisco on the inside of Niakolik Point, no correlation existed between CPUE and water temperature for either large or small Arctic or least cisco.

11. For large Arctic cisco (inside spit) and large least cisco (both sites), a significant negative correlation was observed between CPUE and salinity. CPUE did not correlate with salinity for small Arctic cisco at either trap location. However, in the case of small least cisco, a significant positive relationship was observed at the seaward location.

12. The seaward migration of Babbage River charr occurred in June and early July. Large charr began to return to the Babbage River by late July while the return migration of smolts began about mid-August. Most charr had left coastal waters by September.

13. Most Babbage River charr smolt at age 3. During their first year at sea, charr appear to grow at a rate of approximately 1.25 mm$\cdot$ d^{-1} for an overall increase of 46% in fork length.

14. Broad whitefish, lake whitefish, and inconnu, abundant within the lower Mackenzie River, occurred in small numbers in Phillips Bay.

15. Rainbow smelt were present in Phillips Bay throughout the study period. The majority of those captured in trapnets were large, mature individuals.

16. Young-of-the-year rainbow smelt appeared to arrive in Phillips Bay in late July and early August. The late arrival time suggests that they originated outside the study area (probably the Mackenzie River).

17. Arctic flounder was the second most abundant species captured in trapnets, accounting for 31.5% of the total catch. CPUE data suggest an early summer movement into nearshore areas and a later return to deeper water for overwintering. The abundance of Arctic flounder was greatest at sampling sites located close to the Babbage River. No young-of-the-year Arctic flounder were captured during the study and individuals less than 100 mm in length were rare.

18. Like Arctic flounder, fourhorn sculpin are thought to re-occupy shoreline areas after spring break-up and retreat to deeper water as winter approaches. Sculpin feed voraciously while in nearshore areas, particularly on Isopoda. Young-of-the-year sculpin began to appear along the Phillips Bay coastline in late June, shortly after ice-out. They achieved their greatest abundance in seine catches in late July. Sheltered areas behind spits appear to be of particular importance as nursery areas for small sculpin.

19. Saffron cod may be a more significant member of the Yukon coastal ichthyocommunity than previously believed. They accounted for 1.7% of the trapnet catch in Phillips Bay. Trapnet results revealed an unusual biomodal length-frequency distribution for saffron cod. Fish of the smaller size group (modal size 240-259 mm) were the first to arrive in the study area and the last to depart.

20. Phillips Bay and adjacent coastal waters are important foraging areas for some anadromous and marine fish, particularly Arctic cisco, least cisco, Arctic charr, rainbow smelt, fourhorn sculpin, saffron cod, and Arctic flounder. Phillips Bay itself appears to be of minor importance to broad whitefish, lake whitefish, and inconnu in this respect. Ciscoes fed primarily on epibenthic and plantonic crustaceans (Amphipoda, Mysidacea, Isopoda, and Copepoda). Fourhorn sculpin fed almost exclusively on Isopoda. While the diet of charr, smelt, and saffron cod included small quantities of crustacea, these species were largely piscivorous.

21. Although not captured in large numbers during this study, Arctic cod was found to contribute about half the total food biomass of rainbow smelt.

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Table 1. Inclusive dates for sampling periods (cycles) referred to in this report.

Period/Cycle	Date
1	22 June to 28 June
2	29 June to 5 July
3	6 July to 12 July
4	13 July to 19 July
5	20 July to 26 July
6	27 July to 2 August
7	3 August to 9 August
8	10 August to 16 August
9	17 August to 23 August
10	24 August to 30 August
11	31 August to 6 September
12	7 September to 13 September

Table 2. Fishing effort (h) for each trap by sampling period, Phillips Bay, 1986.

Sampling Period	Fishing Effort (h)		
	Single Trap	Double Trap	Total
1	133.75	105.50	239.25
2	168.00	57.00	225.00
3	168.00	44.50	212.50
4	168.00	165.75	333.75
5	168.00	168.00	336.00
6	168.00	156.50	324.50
7	168.00	168.00	336.00
8	168.00	168.00	336.00
9	139.50	129.00	268.50
10	168.00	153.50	321.50
11	168.00	168.00	336.00
12	33.00	33.00	66.00
Total	1812.25	1516.75	3335.00

Table 3. Mean air temperatures (°C) recorded at Shingle Point during each sampling cycle of the 1986 Phillips Bay study.[1]

Cycle/Date	Mean Daily Maximum	Mean Daily Minimum	Weekly Mean
1. 22-28 June	17.4	5.1	11.3
2. 29 June-5 July	17.4	4.9	11.1
3. 6-12 July	15.4	3.9	9.6
4. 13-19 July	19.1	8.0	13.6
5. 20-26 July	13.4	5.4	9.4
6. 27 July-2 August	15.0	5.1	10.1
7. 3-9 August	17.6	6.9	12.2
8. 10-16 August	14.4	6.1	10.3
9. 17-23 August	8.1	1.1	4.6
10. 24-30 August	6.4	0.1	3.3
11. 31 August-6 September	15.9	5.9	10.9
12. 7-13 September	14.1	3.3	8.7

[1]Temperatures recorded by the Atmospheric Environment Service, Environment Canada.

Table 4. Scientific and common names[1] of fishes captured at Phillips Bay, 1985 and 1986.

Scientific Name	Common Name	Code
Family Clupeidae		
Clupea harengus pallasi Valenciennes	Pacific herring	PCHR
Family Salmonidae		
Coregonus autumnalis (Pallas)	Arctic cisco	ARCS
Coregonus sardinella Valenciennes	Least cisco	LSCS
Coregonus clupeaformis (Mitchill)	Lake whitefish	LKWT
Coregonus nasus (Pallas)	Broad whitefish	BDWT
Prosopium cylindraceum (Pallas)	Round whitefish	RDWT
Stenodus leucichthys (Güldenstadt)	Inconnu	INCO
Salvelinus alpinus (Linnaeus)	Arctic charr	CHAR
Thymallus arcticus (Pallas)	Arctic grayling	ARGR
Family Osmeridae		
Osmerus mordax (Mitchill)	Rainbow smelt	RNSM
Mallotus villosus (Müller)	Capelin	CPLN
Family Esocidae		
Esox lucius Linnaeus	Northern pike	NRPK
Family Gadidae		
Lota lota (Linnaeus)	Burbot	BRBT
Eleginus gracilis (Tilesius)	Saffron cod	SFCD
Boreogadus saida (Lepechin)	Arctic cod	ARCD
Family Gasterosteidae		
Pungitius pungitius (Linnaeus)	Ninespine stickleback	NSSB
Family Stichaeidae		
Acantholumpenus mackayi (Gilbert)	Blackline prickleback[2]	BLBP
Family Ammodytidae		
Ammodytes hexapterus Pallas	Pacific sand lance	PCSN
Family Cottidae		
Myoxocephalus quadricornis (Linnaeus)	Fourhorn sculpin	FHSC
Family Cyclopteridae		
Liparis tunicatus Reinhardt	Kelp snailfish[3]	KLSN
Family Pleuronectidae		
Liopsetta glacialis (Pallas)	Arctic flounder	ARFL

[1]From Robins et al. (1980) except as noted.
[2]Common name recommended by Légendre et al. (1975).
[3]Common name recommended by Able and McAllister (1980).

Table 5. Total catch and species composition in trapnets, Phillips Bay, 1986.

Species	Number Captured	Percent of Total Catch	Percent of Anadromous Catch
Anadromous			
Arctic cisco	52988	37.1	62.7
Least cisco	20482	14.3	24.2
Rainbow smelt	7907	5.5	9.4
Arctic charr	1676	1.2	2.0
Broad whitefish	937	0.7	1.1
Lake whitefish	417	0.3	0.5
Inconnu	109	0.1	0.1
Marine			
Arctic flounder	44974	31.5	
Fourhorn sculpin	10530	7.4	
Saffron cod	2473	1.7	
Arctic cod[1]	154	0.1	
Snailfish[1]	10	<0.1	
Pacific herring	7	<0.1	
Blackline prickleback[1]	4	<0.1	
Capelin[1]	1	<0.1	
Freshwater			
Arctic grayling	59	<0.1	
Ninespine stickleback	50	<0.1	
Round whitefish[1]	16	<0.1	
Northern pike[1]	2	<0.1	
Burbot[1]	1	<0.1	
Total	142797		

[1]Not captured in 1985.

Table 6. Distribution of 1986 trapnet catch by individual codend trap.

Species	Single Trap		Double Trap				Total Catch
			Eastward		Westward		
	N	%[1]	N	%	N	%	
Large Arctic cisco	3664	36.5	5224	52.0	1163	11.6	11051
Small Arctic cisco	23608	55.0	17669	41.2	1660	3.9	42937
Large least cisco	3498	34.0	4273	41.5	2528	24.5	10299
Small least cisco	6019	59.1	3332	32.7	832	8.2	10183
Rainbow smelt	2223	28.1	4021	50.9	1663	21.0	7907
Arctic charr	908	54.2	625	37.3	143	8.5	1676
Broad whitefish	498	53.1	342	36.5	97	10.4	937
Lake whitefish	174	41.7	99	23.7	144	34.5	417
Inconnu	31	28.4	37	33.9	41	37.6	109
Arctic flounder	13661	30.4	21168	47.1	10145	22.6	44974
Fourhorn sculpin	3954	37.6	3425	32.5	3151	29.9	10530
Saffron cod	1011	40.9	608	24.6	854	34.5	2473
Arctic cod	76	49.4	26	16.9	52	33.8	154
Snailfish			6	60.0	4	40.0	10
Pacific herring	6	85.7			1	14.3	7
Blackline prickleback			2	50.0	2	50.0	4
Capelin					1	100.0	1
Arctic grayling	48	81.4	8	13.6	3	5.1	59
Ninespine stickleback	20	40.0	20	40.0	10	20.0	50
Round whitefish	12	75.0	3	18.8	1	6.3	16
Northern pike					2	100.0	2
Burbot					1	100.0	1
Total	59411	41.6	60888	42.6	22498	15.8	142797

[1]Represents percent of total catch for each species.

Table 7. Overall CPUE values recorded in individual codend traps for the major fish species.

Species	CPUE in each Codend Trap				
	Single Trap	Double Trap			All Combined
		Eastward	Westward	Combined	
Large Arctic cisco	2.02	3.44	0.77	4.21	3.01
Small Arctic cisco	12.98	11.65	1.09	12.74	12.88
Large least cisco	1.92	2.82	1.67	4.48	3.09
Small least cisco	3.31	2.20	0.55	2.75	3.05
Rainbow smelt	1.22	2.65	1.10	3.75	2.37
Arctic charr	0.50	0.41	0.09	0.51	0.50
Arctic flounder	7.51	13.96	6.69	20.65	13.49
Fourhorn sculpin	2.18	2.26	2.08	4.34	3.16
Saffron cod	0.56	0.40	0.56	0.96	0.74

Table 8. Total gillnet catch by sampling location, Phillips Bay, 1986.

Species	Site 12		Site 13		Site 14		Total	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
Arctic cisco	45	2	25	31	17	24	87	57
Least cisco	1					1	1	1
Arctic charr	1						1	
Arctic flounder		2		2				4
Fourhorn sculpin		2						2
Rainbow smelt		4		1				5
Saffron cod				1				1
Total	47	10	25	35	17	25	89	70
Minutes of Effort	1045	1055	820	860	975	975	2840	2890

Table 9. Total seine catch by sampling location, Phillips Bay, 1986.

Species	Number of Fish Captured at each Location						Total	
	1	2	6	66	7	8	N	%
Arctic cisco	118	330	3	232	29	107	819	38.5
Least cisco		4	4	1	3	1	13	0.6
Fourhorn sculpin	64	80	127	384	111	311	1077	50.5
Arctic flounder	6	26	12	5	9	38	96	4.5
Rainbow smelt	12	87	4	4	7	1	115	5.4
Arctic charr		1	1	1			3	0.1
Ninespine stickleback	1	3		1	1		6	0.3
Arctic grayling					1		1	<0.1
Total	201	531	151	628	161	458	2130	
Effort (metres of shoreline seined)	324	437	451	490	586	551	2839	

Table 10. Results of correlation tests between fish abundance (CPUE) and water temperature for Arctic and least cisco.

Location/Species/Size	Number of Observations	Correlation Coefficient (r)	Prob > [r] Under $H_0 : \rho H_0 = 0$
Inside Niakolik Point			
Large Arctic Cisco	77	-0.1531	0.1838
Small Arctic Cisco	77	0.1005	0.3845
Large Least Cisco	77	-0.2540*	0.0258
Small Least Cisco	77	0.1524	0.1858
Outside Niakolik Point			
Large Arctic Cisco	67	-0.0825	0.5067
Small Arctic Cisco	66	-0.0521	0.6777
Large Least Cisco	68	-0.2251	0.0650
Small Least Cisco	68	0.1798	0.1424

* Significant at 95% level.

Table 11. Results of correlation tests between fish abundance (CPUE) and salinity for Arctic and least cisco.

Location/Species/Size	Number of Observations	Correlation Coefficient (r)	Prob > [r] Under $H_0 : \rho H_0 = 0$
Inside Niakolik Point			
Large Arctic Cisco	77	-0.3893**	0.0005
Small Arctic Cisco	77	0.1087	0.3469
Large Least Cisco	77	-0.2706*	0.0173
Small Least Cisco	77	0.1144	0.3218
Outside Niakolik Point			
Large Arctic Cisco	67	-0.1323	0.2859
Small Arctic Cisco	66	0.0895	0.4749
Large Least Cisco	68	-0.3408**	0.0045
Small Least Cisco	68	0.2577*	0.0339

* Significant at 95% level.
** Significant at 99% level.

Table 12. Length-frequency distribution for Arctic cisco captured in gillnets at Phillips Bay, 1986.

Fork Length (mm)	Surface		Bottom		Total	
	N	%	N	%	N	%
200-224			2	3.5	2	1.4
225-249			1	1.8	1	0.7
250-274	6	7.0	2	3.5	8	5.6
275-299	2	2.3	2	3.5	4	2.8
300-324	12	14.0	8	14.0	20	14.0
325-349	25	29.1	23	40.4	48	33.6
350-374	33	38.4	17	29.8	50	35.0
375-399	7	8.1	2	3.5	9	6.3
400-424	1	1.2			1	0.7
Total	86		57		143	

Table 13. Length-frequency distributions for fish captured in seines at Phillips Bay, 1986.

Fork Length (mm)	ARCS		LSCS		FHSC		ARFL		RNSM		CHAR		NSSB		ARGR	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
0-24	4	0.9			567	84.9			42	36.5						
25-49	385	85.4	2	15.4	58	8.7	2	2.1	71	61.7			4	100.0		
50-74	52	11.5	3	23.1	35	5.2	2	2.1	1	0.9						
75-99	7	1.6			8	1.2	4	4.2	1	0.9	1	33.3				
100-124	1	0.2	2	15.4	9	1.3	2	2.1							1	100.0
125-149			1	7.7	4	0.6	9	9.4								
150-174							23	24.0			1	33.3				
175-199					4	0.6	32	33.3								
200-224					1	0.2	15	15.6			1	33.3				
225-249			1	7.7	1	0.2	4	4.2								
250-274							3	3.1								
275-299			2	15.4	1	0.2										
300-324			1	7.7												
325-349	1	0.2	1	7.7												
350-374																
375-399																
400-424	1	0.2														
Total	451		13		668		96		115		3		4		1	

Table 14. Length-frequency distribution by sampling period for small Arctic cisco captured in seines at Phillips Bay, 1986.

Fork Length (mm)	Number by Sampling Period										Total	
	1	2	3	4	5	6	7	8	9	10	N	%
15-19											0	
20-24				2	2						4	0.9
25-29			1	1	8						10	2.2
30-34				1	22	21	7				51	11.4
35-39				1	23	71	22		4	1	122	27.2
40-44					14	51	41		11	4	121	26.9
45-49					2	31	39		7	2	81	18.0
50-54						6	14		3		23	5.1
55-59						4	9		2		15	3.3
60-64						2	5			1	8	1.8
65-69							4				4	0.9
70-74							2				2	0.4
75-79							1				1	0.2
80-84												
85-89							1				1	0.2
90-94				1			1				2	0.4
95-99				1			2				3	0.7
100-104												
105-109												
110-114												
115-119												
120-124		1									1	
Total	0	1	1	7	71	186	148	ND	27	8	449	

Table 15. Length-frequency distribution for broad whitefish from each trapnet, Phillips Bay, 1986.

Fork Length (mm)	Single		Eastward		Westward		Total	
	N	%	N	%	N	%	N	%
0-24								
25-49	3	0.6	3	0.9	4	4.1	10	1.1
50-74	414	83.1	169	49.4	37	38.1	620	66.2
75-99	16	3.2	17	5.0	7	7.2	40	4.3
100-124	14	2.8	8	2.3	6	6.2	28	3.0
149	12	2.4	9	2.6	4	4.1	25	2.7
174	3	0.6	6	1.8	3	3.1	12	1.3
199	6	1.2	4	1.2	5	5.2	15	1.6
200-224	3	0.6	1	0.3	3	3.1	7	0.7
249	2	0.4	8	2.3			10	1.1
274	2	0.4	2	0.6			4	0.4
299			1	0.3			1	0.1
300-324	6	1.2			1	1.0	7	0.7
349	1	0.2	1	0.3	3	3.1	5	0.5
374	2	0.4	3	0.9	6	6.2	11	1.2
399	3	0.6	3	0.9	1	1.0	7	0.7
400-424	2	0.4	4	1.2	2	2.1	8	0.9
449	4	0.8	9	2.6	2	2.1	15	1.6
474	3	0.6	24	7.0	5	5.2	32	3.4
499	1	0.2	32	9.4	4	4.1	37	3.9
500-524			25	7.3	3	3.1	28	3.0
549			6	1.8	1	1.0	7	0.7
574	1	0.2	5	1.5			6	0.6
599			2	0.6			2	0.2
Total	498		342		97		937	

Table 16. Length-frequency distribution for lake whitefish from each trapnet, Phillips Bay, 1986.

Fork Length (mm)	Single		Eastward		Westward		Total	
	N	%	N	%	N	%	N	%
0-24								
25-49								
50-74			1	1.0			1	0.3
75-99								
100-124	1	0.6			1	0.8	2	0.5
149	1	0.6	1	1.0	1	0.8	3	0.8
174	1	0.6			1	0.8	2	0.5
199	5	3.0			2	1.5	7	1.8
200-224	5	3.0	1	1.0	2	1.5	8	2.0
249	8	4.7			3	2.3	11	2.8
274	22	13.0	6	6.3	10	7.6	38	9.6
299	25	14.8	12	12.5	25	19.1	62	15.7
300-324	38	22.5	17	17.7	39	29.7	94	23.7
349	30	17.8	23	24.0	27	20.6	80	20.2
374	18	10.7	12	12.5	13	9.9	43	10.9
399	8	4.7	7	7.3	2	1.5	17	4.3
400-424	5	3.0	10	10.4	3	2.3	18	4.5
449	2	1.2	3	3.1	2	1.5	7	1.8
474			3	3.1			3	0.8
499								
Total	169		96		131		396	

Table 17. Length-frequency distribution for inconnu from each trapnet, Phillips Bay, 1986.

Fork Length (mm)	Single		Eastward		Westward		Total	
	N	%	N	%	N	%	N	%
0-24								
25-49								
50-74	2	6.5	7	18.9	3	7.3	12	11.0
75-99	4	12.9	5	13.5	2	4.9	11	10.1
100-124	3	9.7	2	5.4			5	4.6
149								
174								
199								
200-224								
249	1	3.2					1	0.9
274								
299	1	3.2					1	0.9
300-324								
349								
374					1	2.4	1	0.9
399			1	2.7			1	0.9
400-424								
449	3	9.7	3	8.1	7	17.1	13	11.9
474	4	12.9	3	8.1	6	14.6	13	11.9
499	8	25.8	4	10.8	4	9.8	16	14.7
500-524	2	6.5	3	8.1	5	12.2	10	9.2
549	1	3.2	2	5.4	5	12.2	8	7.3
574			3	8.1	3	7.3	6	5.5
599			2	5.4			2	1.8
600-624					4	9.8	4	3.7
649			1	2.7			1	0.9
674	1	3.2			1	2.4	2	1.8
699								
700-724	1	3.2	1	2.7			2	1.8
Total	31		37		41		109	

Table 18. Length-frequency distribution by sampling period for Arctic charr captured in trapnets at Phillips Bay, 1986.

Fork Length (mm)	Sampling Period 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %	6 N	6 %	7 N	7 %	8 N	8 %	9 N	9 %	10 N	10 %	11 N	11 %	12 N	12 %	Total N	Total %
0- 24																					1	2.2			1	0.1
25- 49																									1	0.1
50- 74	1	0.3																	1	0.3					16	1.0
75- 99	4	1.1	7	2.3	1	1.3	2	4.9	1	4.2															12	0.8
100-124					3	3.9	4	9.8	3	12.5	2	2.9													100	6.3
125-149	46	12.9	28	9.0	9	11.7	6	14.6			3	4.4					2	1.6	4	1.1	2	4.3			337	21.2
150-174	128	35.9	133	42.9	47	61.0	12	29.3			1	1.5					3	2.4	6	1.6	6	13.0	1	16.7	137	8.6
175-199	44	12.3	47	15.2	9	11.7	8	19.5	9	37.5	6	8.8			1	1.8	2	1.6	7	1.9	3	6.5	1	16.7	85	5.3
200-224	6	1.7	13	4.2	4	5.2	1	2.4	1	4.2	3	4.4			4	7.1	7	5.5	37	10.0	8	17.4	1	16.7	228	14.3
225-249	6	1.7	7	2.3											5	8.9	26	20.5	167	45.0	15	32.6	2	33.3	164	10.3
250-274	1	0.3	5	1.6											7	12.5	34	26.8	107	28.8	9	19.6	1	16.7	34	2.1
275-299			1	0.3											3	5.4	10	7.9	18	4.9	2	4.3			20	1.3
300-324	2	0.6	1	0.3											4	7.1	7	5.5	6	1.6					21	1.3
325-349	6	1.7	6	1.9											2	3.6	4	3.2	3	0.8					18	1.1
350-374	3	0.8	8	2.6	1	1.3									5	8.9	1	0.8							43	2.7
375-399	13	3.6	11	3.5	1	1.3	2	4.9			1	1.5	5	4.6	5	8.9	5	3.9							53	3.3
400-424	21	5.9	7	2.3	1	1.3			1	4.2	2	2.9	9	8.3	6	10.7	5	3.9	1	0.3					61	3.8
425-449	18	5.0	7	2.3			1	2.4	1	4.2	3	4.4	14	12.8	4	7.1	9	7.1	4	1.1					60	3.8
450-474	16	4.5	7	2.3	1	1.3	1	2.4	2	8.3	10	14.7	18	16.5	2	3.6	2	1.6	1	0.3					54	3.4
475-499	17	4.8	7	2.3			2	4.9			5	7.4	16	14.7	2	3.6	2	1.6	3	0.8					63	4.0
500-524	9	2.5	7	2.3					2	8.3	13	19.1	25	22.9	2	3.6	4	3.2	1	0.3					51	3.2
525-549	9	2.5	6	1.9			1	2.4	2	8.3	14	20.6	14	12.8	1	1.8	2	1.6	2	0.5					22	1.4
550-574	4	1.1	2	0.6			1	2.4			2	2.9	7	6.4	2	3.6	1	0.8	3	0.8					7	0.4
575-599	2	0.6							1	4.2	3	4.4					1	0.8							2	0.1
600-624													1	0.9	1	1.8									2	0.1
625-649	1	0.3							1	4.2																
Total	357		310		77		41		24		68		109		56		127		371		46		6		1592	

Table 19. Mean fork length (mm), mean weight (g), mean condition factor (K), sex ratio, and maturity by age group for Arctic charr captured at Phillips Bay.

Otolith Age (yr)	Number of Fish	Fork Length Mean	Fork Length SD	Fork Length Range	Weight Mean	Weight SD	Weight Range	Mean Condition Factor (K)	Males n	Males % Mature	Females n	Females % Mature	Number Sex Unknown
0+													
1	9[1]	68	9	56- 86									9
2	1[2]	146			21								1
3	9[2]	171	8	163-182	34	5	29- 42						9
4	2	213	25	195-231	76	18	62- 90				1	0	1
5	3	259	63	187-305	174	109	53- 265	0.88			3	0	
6	8	373	21	348-412	469	110	319- 643	0.89	1	100	5	40	2
7	24	396	35	324-475	547	177	280-1008	0.85	6	0	12	100	6
8	14	444	35	380-490	743	219	391-1063	0.83	6	17	8	100	
9	14	468	36	394-516	914	229	495-1320	0.87	2	0	12	100	
10	4	553	55	523-635	1583	511	1262-2345	0.91	2	100	2	100	
11	3	523	50	479-577	1341	454	963-1844	0.91	1	100	2	100	
12	3	525	37	492-565	1297	232	1161-1565	0.89			3	100	
13	1	544			1345			0.84			1	100	
14	1	531			1176			0.79			1	100	
Total	96								18		50		28

[1] Assumed age 1 on basis of length (Parr marks present).
[2] Captured in trapnets 23-24 June 1986.

Table 20. Length-frequency distribution for rainbow smelt from each trapnet, Phillips Bay, 1986.

Fork Length (mm)	Single		Eastward		Westward		Total	
	N	%	N	%	N	%	N	%
50-59	2	0.2					2	0.1
60-69	2	0.2	1	0.1	3	0.8	6	0.3
70-79	9	0.9	2	0.3	6	1.6	17	0.8
89	14	1.4	8	1.1	16	4.3	38	1.9
99	25	2.5	8	1.1	7	1.9	40	2.0
100-109	31	3.2	6	0.9	7	1.9	44	2.1
119	20	2.0	7	1.0	9	2.4	36	1.8
129	21	2.1	6	0.9	5	1.4	32	1.6
139	19	1.9	4	0.6	8	2.2	31	1.5
149	25	2.5	8	1.1	6	1.6	39	1.9
159	34	3.5	6	0.9	4	1.1	44	2.1
169	18	1.8	7	1.0	1	0.3	26	1.3
179	10	1.0	5	0.7	3	0.8	18	0.9
189	12	1.2	2	0.3	6	1.6	20	1.0
199	17	1.7	4	0.6	5	1.4	26	1.3
200-209	12	1.2	7	1.0	2	0.5	21	1.0
219	23	2.3	13	1.9	5	1.4	41	2.0
229	19	1.9	12	1.7	8	2.2	39	1.9
239	59	6.0	36	5.2	14	3.8	109	5.3
249	125	12.7	82	11.7	45	12.2	252	12.3
259	196	20.0	160	22.9	78	21.1	434	21.2
269	151	15.4	150	21.5	74	20.1	375	18.3
279	93	9.5	109	15.6	27	7.3	229	11.2
289	35	3.6	34	4.9	22	6.0	91	4.4
299	6	0.6	14	2.0	6	1.6	26	1.3
300-309	3	0.3	3	0.4	2	0.5	8	0.4
319			2	0.3			2	0.1
329			1	0.1			1	<0.1
339								
349			1	0.1			1	<0.1
359	1	0.1					1	<0.1
Total	982		698		369		2049	

Table 21. Length-frequency distribution by sampling period for rainbow smelt captured in trapnets at Phillips Bay, 1986.

Fork Length (mm)	Sampling Period 1 N	1 %	2 N	2 %	3 N	3 %	4 N	4 %	5 N	5 %	6 N	6 %	7 N	7 %	8 N	8 %	9 N	9 %	10 N	10 %	11 N	11 %	12 N	12 %	Total N	Total %
0- 19																										
20- 39																	1	0.6							2	0.1
40- 59			1	0.7																						
60- 79	10	4.7	2	1.4					1	0.5			2	1.0	1	0.5	2	1.3	2	1.1	2	1.0	1	1.9	23	1.1
80- 99	47	22.3	5	3.4			1	0.7	8	3.8					4	2.2	4	2.6			4	1.9	4	7.5	78	3.8
100-119	18	8.5			3	2.1	1	0.7	14	6.6	2	0.9			13	7.1	7	4.5	1	0.6	10	4.8	11	20.8	80	3.9
120-139	14	6.6	3	2.1	2	1.4	2	1.5	9	4.2	2	0.9	3	1.4	6	3.3	9	5.8	3	1.7	5	2.4	5	9.4	63	3.1
140-159	11	5.2	1	0.7	9	6.3	3	2.2	11	5.2	6	2.8	7	3.3	10	5.4	14	9.0	7	3.9	4	1.9			83	4.1
160-179	3	1.4	5	3.4	2	1.4	1	0.7	8	3.8	3	1.4	2	1.0	3	1.6	8	5.1	3	1.7	2	1.0	4	7.5	44	2.1
180-199	2	0.9	2	1.4			1	0.7	12	5.7	4	1.9	5	2.4	5	2.7	5	3.2	1	0.6	3	1.4	6	11.3	46	2.2
200-219	3	1.4	5	3.4	5	3.5	5	3.7	5	2.4	4	1.9	6	2.9	10	5.4	6	3.8	3	1.7	4	1.9	6	11.3	62	3.0
220-239	9	4.3	19	13.1	20	13.9	6	4.5	10	4.7	19	9.0	29	13.8	13	7.1	11	7.1	7	3.9	3	1.4			148	7.2
240-259	44	20.9	57	39.3	60	41.7	66	49.3	82	38.7	94	44.6	79	37.6	58	31.5	36	23.1	51	28.5	56	26.7	3	5.7	686	33.5
260-279	41	19.4	38	26.2	36	25.0	35	26.1	48	22.6	62	29.4	59	28.1	50	27.2	44	28.2	87	48.6	94	44.8	10	18.9	604	29.5
280-299	7	3.3	6	4.1	7	4.9	11	8.2	3	1.4	15	7.1	18	8.6	8	4.3	8	5.1	12	6.7	21	10.0	1	1.9	117	5.7
300-319	1	0.5					2	1.5	1	0.5					1	0.5			2	1.1	1	0.5	2	3.8	10	0.5
320-339																					1	0.5			1	<0.1
340-359	1	0.5	1	0.7																					2	0.1
360-379																										
Total	211		145		144		134		212		211		210		184		156		179		210		53		2049	

Table 22. Mean fork length (mm), mean weight (g), mean condition factor (K), sex ratio, and maturity by age group for rainbow smelt captured at Phillips Bay in 1985 and 1986.

Otolith Age (yr)	Number of Fish	Fork Length Mean	Fork Length SD	Fork Length Range	Weight Mean	Weight SD	Weight Range	Mean Condition Factor (K)	Males n	Males % Mature	Females n	Females % Mature	Number Sex Unknown
0+	31[1]	14	2.2	10- 19									31
1	46[2]	37	2.0	31- 42									46
2	9[3]	61	5.1	52- 68									9
3	5	98	5.7	88-103	5	0.9	4- 6	0.58					5
4	7	144	14.3	120-159	21	6.5	10- 29	0.70					7
5													
6													
7													
8	8	237	12.0	213-253	89	15.9	69-116	0.67	5	100	3	50	
9	17	258	20.1	222-291	116	31.7	69-193	0.68	4	67	13	82	
10	6	265	13.5	245-285	126	22.0	93-152	0.68	4	100	2	100	
11	1	292			217			0.87	1	100			
12	1	282			167			0.74	1	100			
13	1	293			158			0.63			1	100	
14	1	302			205			0.74	1	100			
15													
16													
17	2	312	2.1	310-313	195	33.9	171-219	0.65	2	100			
Total	135								18		19		98

[1] Captured in seines 23 July 1985; age based on length-frequency.
[2] Captured in seines 22 June 1986; age based on length-frequency.
[3] Captured in seines 30 June - 6 July 1985 (n = 8) and 22 June 1986 (n = 1); age based on length-frequency.

Table 23. Mean total length (mm), mean weight (g), mean condition factor (K), sex ratio, and maturity by age group for Arctic flounder captured at Phillips Bay, 1985.

Otolith Age (yr)	Number of Fish	Total Length			Weight			Mean Condition Factor (K)	Males		Females		Number Sex Unknown
		Mean	SD	Range	Mean	SD	Range		n	% Mature	n	% Mature	
0+													
1	6[1]	38	6.3	29- 44									6
2	1	69			4			1.22					1
3	1	97			10			1.10	1	0			
4	2	124	13.4	114-133	22	7.8	16- 27	1.14	1	0	1	0	
5	3	145	21.2	130-169	40	19.5	25- 62	1.32	1	0	1	0	1
6	10	164	18.3	137-191	53	19.0	31- 89	1.22	3	33	6	0	1
7	3	189	14.0	173-200	76	12.5	63- 88	1.13	1	100	2	50	
8	6	203	13.6	184-217	100	15.4	79-122	1.19	2	100	4	25	
9	4	210	11.7	198-220	110	23.7	80-132	1.19	1		3	67	
10	2	229	21.9	213-244	157	42.4	127-187	1.32			2	50	
11	2	239	15.6	228-250	154	19.8	140-168	1.13			2	100	
12	5	254	10.1	238-265	186	19.3	160-205	1.14			5	100	
13	1	282			244			1.09			1	100	
14	1	232			144			1.15	1				
15	1	275			271			1.30			1	100	
Total	48								11		28		9

[1] Captured during 1986; aged by length-frequency.

Table 24. Mean total length (mm), mean weight (g), mean condition factor (K), sex ratio, and maturity by age group for fourhorn sculpin captured at Phillips Bay, 1985.

Otolith Age (yr)	Number of Fish	Total Length			Weight			Mean Condition Factor (K)	Males		Females		Number Sex Unknown
		Mean	SD	Range	Mean	SD	Range		n	% Mature	n	% Mature	
0+	33[1]	14	1.5	11- 16									33
1													
2													
3	1	126			13			0.65	1	0			
4	6	143	19.2	109-167	31	12.2	21- 54	1.04			6	0	
5	2	178	10.6	170-185	37	1.4	36- 38	0.66	2	0			
6	2	185	13.4	175-194	57	26.9	38- 76	0.91			2	50	
7	4	194	4.0	188-197	59	8.8	50- 70	0.81	3	33	1	100	
8	6	216	11.3	201-230	92	23.5	62-126	0.91	3	33	3	67	
9	6	215	12.6	198-233	96	30.5	72-153	0.97	2	50	4	50	
10	9	237	26.8	204-284	131	53.1	76-237	0.98	5	60	4	100	
11	6	268	30.3	231-310	189	81.8	108-298	0.99	1	100	5	100	
12	4	263	14.0	251-282	194	21.4	167-215	1.07			4	100	
13	2	281	0.7	280-281	221	50.2	185-256	1.00	1	0	1	100	
14	2	280	7.1	275-285	208	16.3	196-219	0.95			2	50	
Total	83								18		32		33

[1] Captured in seines 28 June - 11 July 1986.

Table 25. Length-frequency distribution for small fourhorn sculpin by sampling period, Phillips Bay, 1986.

Total Length (mm)	Number by Sampling Period												Total	
	1	2	3	4	5	6	7	8	9	10	11	12	N	%
10-14	4	15	3	4	10	1	1						38	5.7
15-19		2	8	35	63	115	86	15	6	2	5		337	50.4
20-24				2	7	34	39	7	25	66	12		192	28.7
25-29					1	7	4		2	23	1		38	5.7
30-34							3	1	1	1			6	0.9
35-39						1		1			1		3	0.4
40-44	1	1	2	1	1			1					7	1.0
45-49		1			1			1		1			4	0.6
50-54		1	2	1	1	1							6	0.9
55-59		3	1	2									6	0.9
60-64		1			4	1							6	0.9
65-69		2		1	1	1							5	0.7
70-74		6	3	1	1	1							12	1.8
75-79		1	1				2						4	0.6
80-84														
85-89								1					1	0.2
90-94				1									1	0.2
95-99						1		1					2	0.3
Total	5	33	20	48	90	163	135	28	34	93	19	MD	668	

Table 26. Length-frequency distribution for saffron cod from each trapnet, Phillips Bay, 1986.

Total Length (mm)	Single		Eastward		Westward		Total	
	N	%	N	%	N	%	N	%
120-129	1	0.2					1	0.1
139								
149					1	0.2	1	0.1
159	4	0.7	1	0.3			5	0.3
169	1	0.2	2	0.5	3	0.5	6	0.4
179	7	1.1	1	0.3	1	0.2	9	0.6
189	11	1.8	6	1.6	2	0.3	19	1.2
199	15	2.5	3	0.8	5	0.8	23	1.4
200-209	27	4.4	4	1.1	12	1.9	43	2.7
219	49	8.0	10	2.7	14	2.2	73	4.5
229	80	13.1	17	4.6	26	4.1	123	7.6
239	72	11.8	24	6.5	38	6.0	134	8.3
249	73	12.0	37	10.1	61	9.6	171	10.6
259	45	7.4	49	13.4	64	10.1	158	9.8
269	37	6.1	32	8.7	55	8.7	124	7.7
279	26	4.3	21	5.7	45	7.1	92	5.7
289	11	1.8	15	4.1	17	2.7	43	2.7
299	5	0.8	8	2.2	11	1.7	24	1.5
300-309	1	0.2	1	0.3			2	0.1
319	1	0.2	2	0.5	1	0.2	4	0.2
329								
339								
349	1	0.2			1	0.2	2	0.1
359	3	0.5			6	0.9	9	0.6
369	8	1.3	4	1.1	7	1.1	19	1.2
379	7	1.1	6	1.6	8	1.3	21	1.3
389	22	3.6	10	2.7	24	3.8	56	3.5
399	17	2.8	19	5.2	48	7.6	84	5.2
400-409	29	4.8	23	6.3	48	7.6	100	6.2
419	27	4.4	22	6.0	51	8.0	100	6.2
429	15	2.5	14	3.8	32	5.0	61	3.8
439	5	0.8	11	3.0	29	4.6	45	2.8
449	4	0.7	11	3.0	10	1.6	25	1.6
459	3	0.5	7	1.9	8	1.3	18	1.1
469	2	0.3	1	0.3	4	0.6	7	0.4
479			2	0.5	2	0.3	4	0.2
489			2	0.5			2	0.1
499								
500-509								
519			1	0.3			1	0.1
529			1	0.3			1	0.1
Total	609		367		634		1610	

Table 27. Length-frequency distribution by sampling period for saffron cod captured in trapnets at Phillips Bay, 1986.

Total Length (mm)	Sampling Period 1		2		3		4		5		6		7		8		9		10		11		12		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
100-119																										
120-139			1	0.6																						
140-159			1	0.6	2	1.4	1	0.8	1	0.9	1	1.0													1	0.1
160-179			3	1.9	1	0.7	3	2.3	2	1.7	1	1.0	2	1.1			1	0.8			2	0.7			6	0.4
180-199	3	27.3	10	6.3	9	6.2	4	3.1	5	4.3	7	6.8	1	0.6	2	1.3	1	0.8							15	0.9
200-219	3	27.3	29	18.2	22	15.2	18	14.0	7	6.0	6	5.8	12	6.7	2	1.3	6	4.7	3	2.3	7	2.5	1	1.3	42	2.6
220-239	2	18.2	55	34.6	42	29.0	49	38.0	34	29.3	10	9.7	12	6.7	6	3.8	10	7.9	5	3.8	26	9.4	6	8.0	116	7.2
240-259	2	18.2	23	14.5	25	17.2	20	15.5	33	28.4	14	13.6	29	16.3	16	10.1	29	22.8	33	25.2	74	26.7	30	40.0	257	16.0
260-279			6	3.8	4	2.8	5	3.9	9	7.8	6	5.8	14	7.9	8	5.1	16	14.2	30	22.9	88	31.8	28	37.3	329[1]	20.4
280-299			2	1.3					2	1.7			1	0.6			4	3.2	9	6.9	39	14.1	10	13.3	216	13.4
300-319					1	0.7							1	0.6			1	0.8			3	1.1			67	4.2
320-339																									6	0.4
340-359			2	1.3	1	0.7	1	0.8	1	0.9	1	1.0	3	1.7	2	1.3										
360-379			3	1.9	6	4.1	3	2.3	1	0.9	6	5.8	5	2.8	7	4.4	1	0.8	5	3.8	3	1.1			11	0.7
380-399	1	9.1	8	5.0	11	7.6	12	9.3	5	4.3	14	13.6	24	13.5	34	21.5	12	9.4	10	7.6	9	3.2			40	2.5
400-419			9	5.7	15	10.3	4	3.1	10	8.6	21	20.4	36	20.2	59	37.3	19	15.0	18	13.7	9	3.2			140	8.7
420-439			6	3.8	4	2.8	3	2.3	3	2.6	7	6.8	27	15.2	17	10.8	18	14.2	10	7.6	11	4.0			200	12.4
440-459			1	0.6	2	1.4	4	3.1	3	2.6	5	4.9	11	6.2	3	1.9	4	3.2	7	5.3	3	1.1			106	6.6
460-479							2	1.6			1	1.0			2	1.3	3	2.4	1	0.8	2	0.7			43	2.7
480-499											2	1.9													11	0.7
500-519																									2	0.1
520-539											1	1.0									1	0.4			1	0.1
																									1	0.1
Total	11		159		145		129		116		103		178		158		127		131		277		75		1610[1]	

[1] Includes one fish that was unassignable by sampling period.

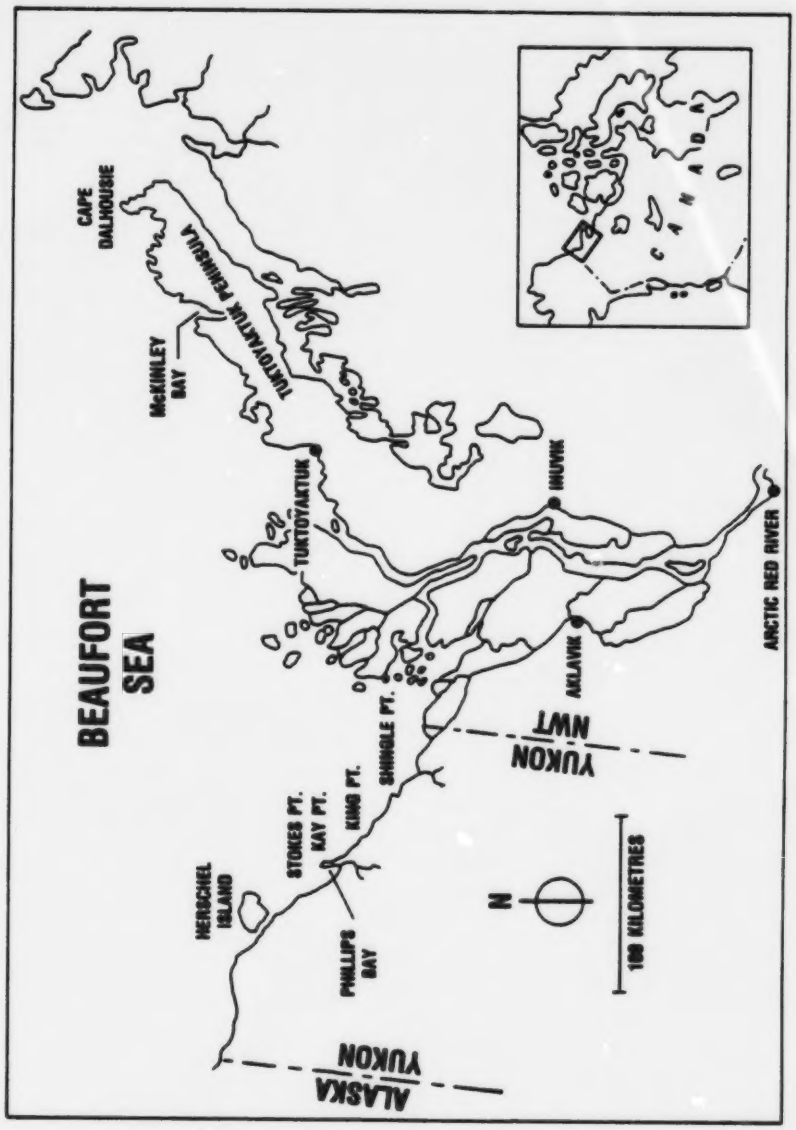

Fig. 1. The Mackenzie Delta and southern Beaufort Sea showing the location of the study area.

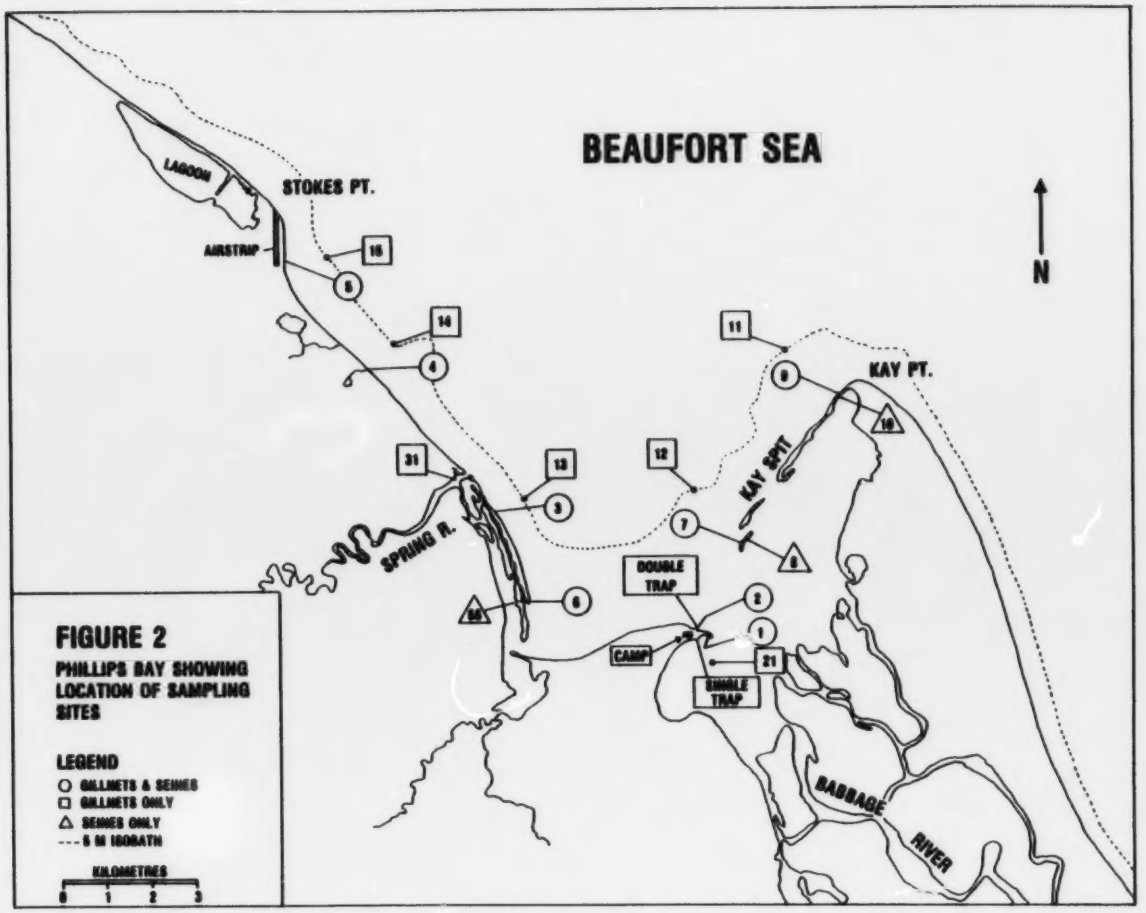

Fig. 2. Phillips Bay showing location of sampling sites.

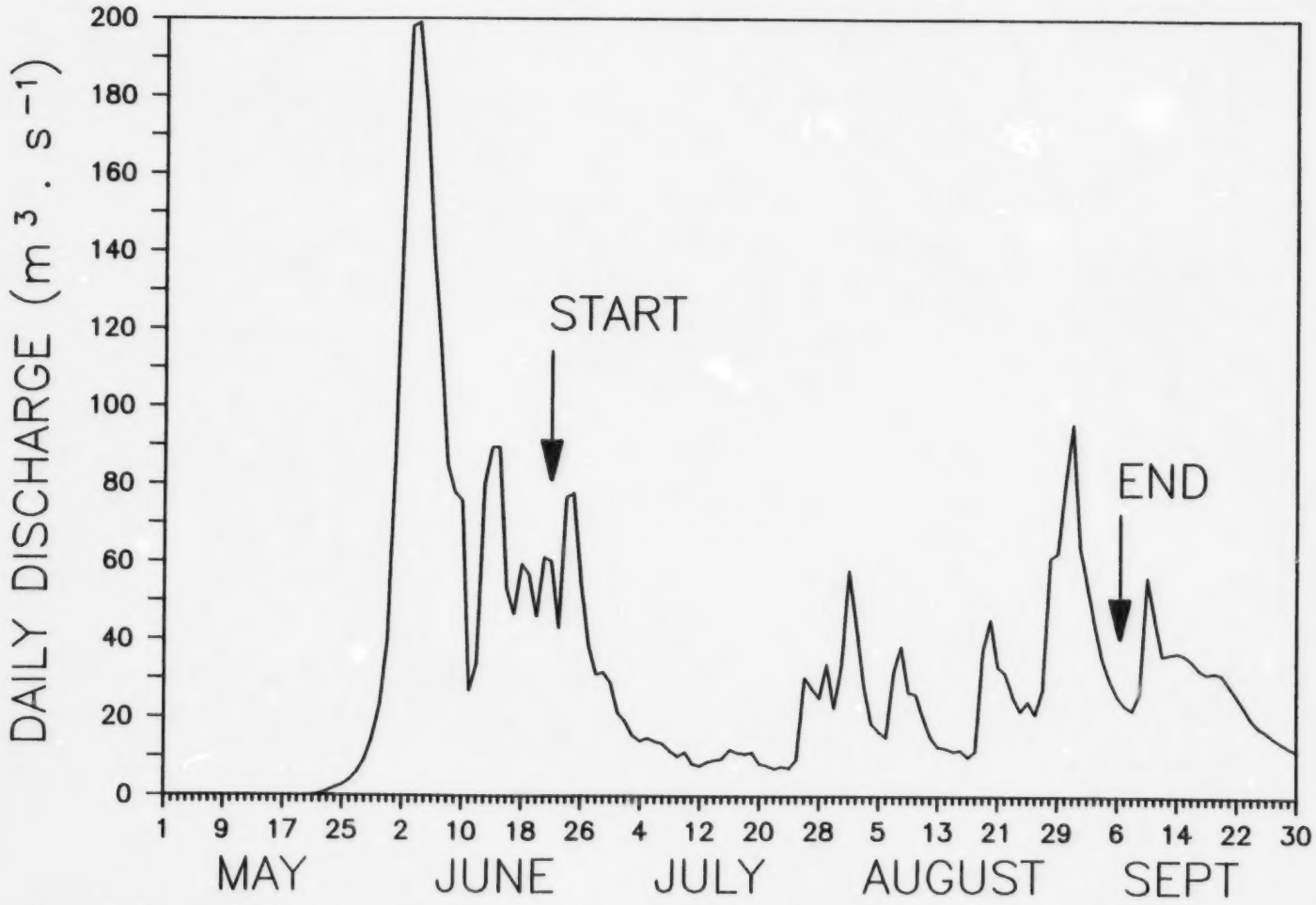

Fig. 3. Daily discharge of the Babbage River from 1 May to 30 September 1986. (Data from Environment Canada 1987). Arrows indicate beginning and end of trapnetting operations.

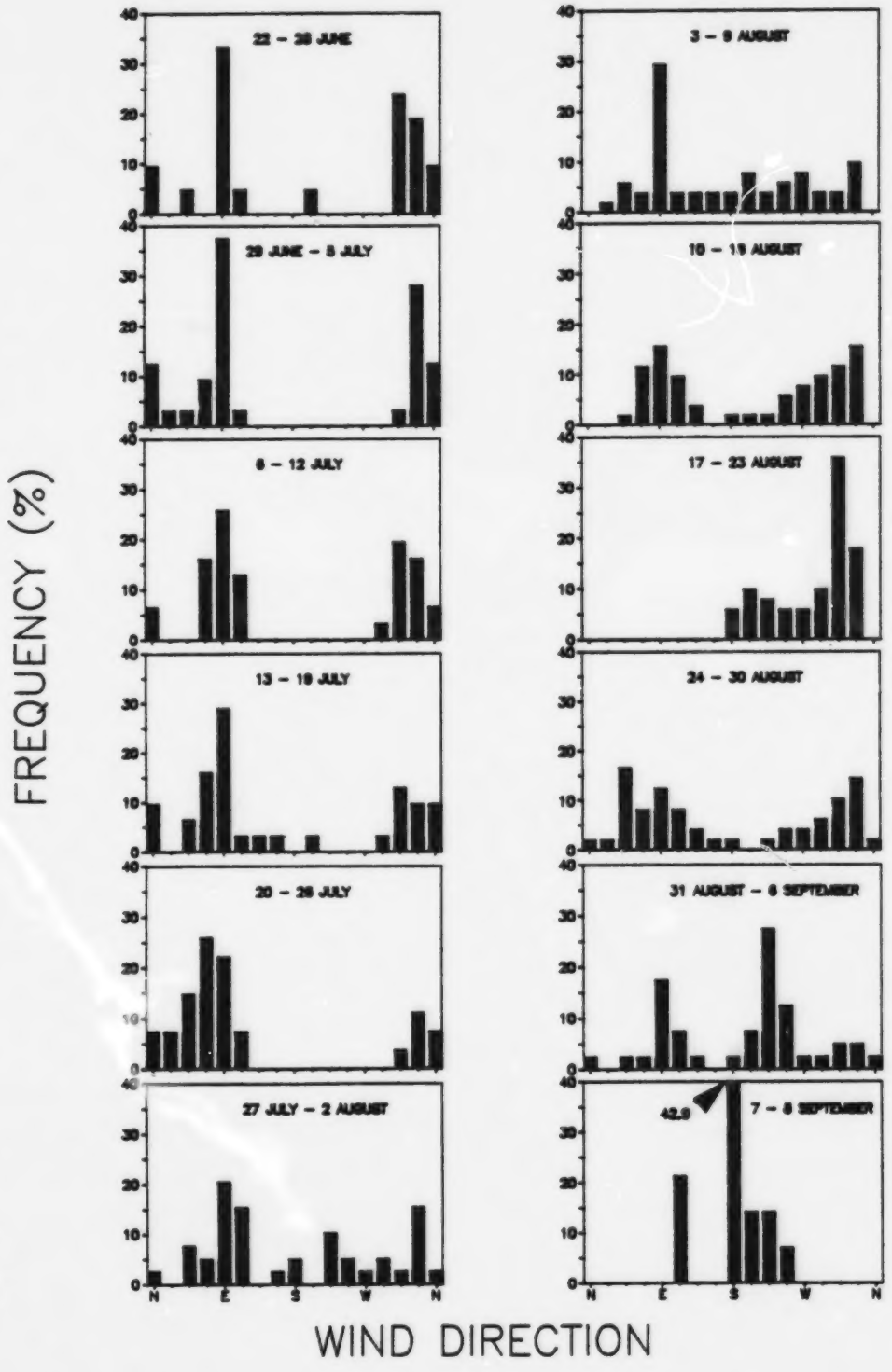

Fig. 4. Frequency distribution of winds recorded at Shingle Point during each sampling cycle of the 1986 Phillips Bay study.

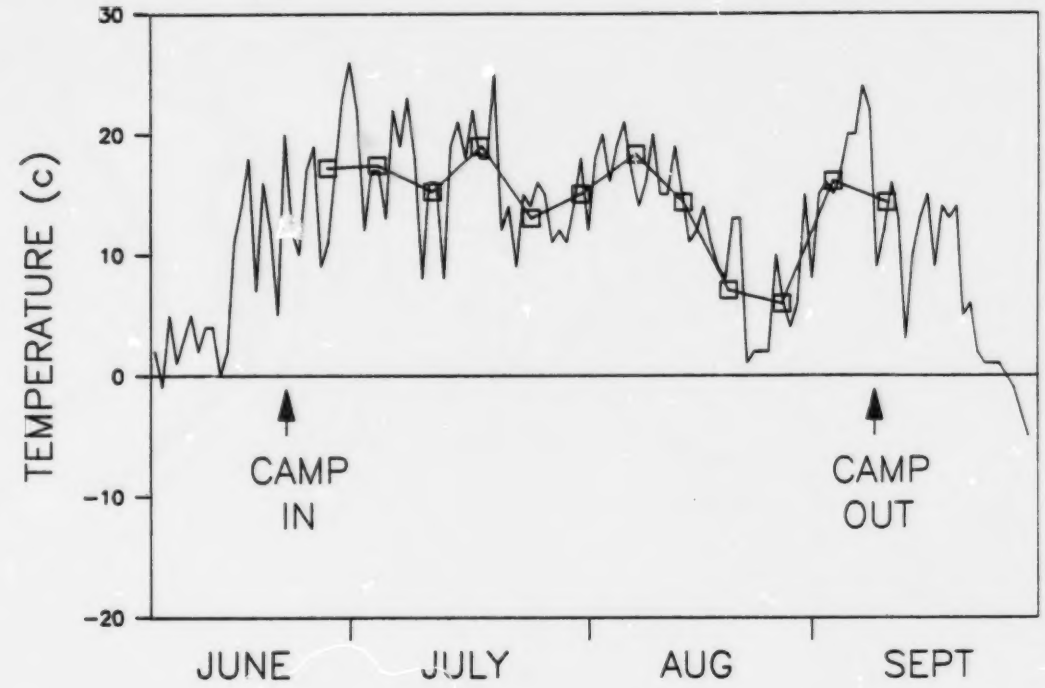

Fig. 5. Maximum daily air temperatures recorded at Shingle Point, 1 June - 30 September 1986, by the Atmospheric Environment Service, Environment Canada. Squares represent the mean daily maximum within each sampling cycle.

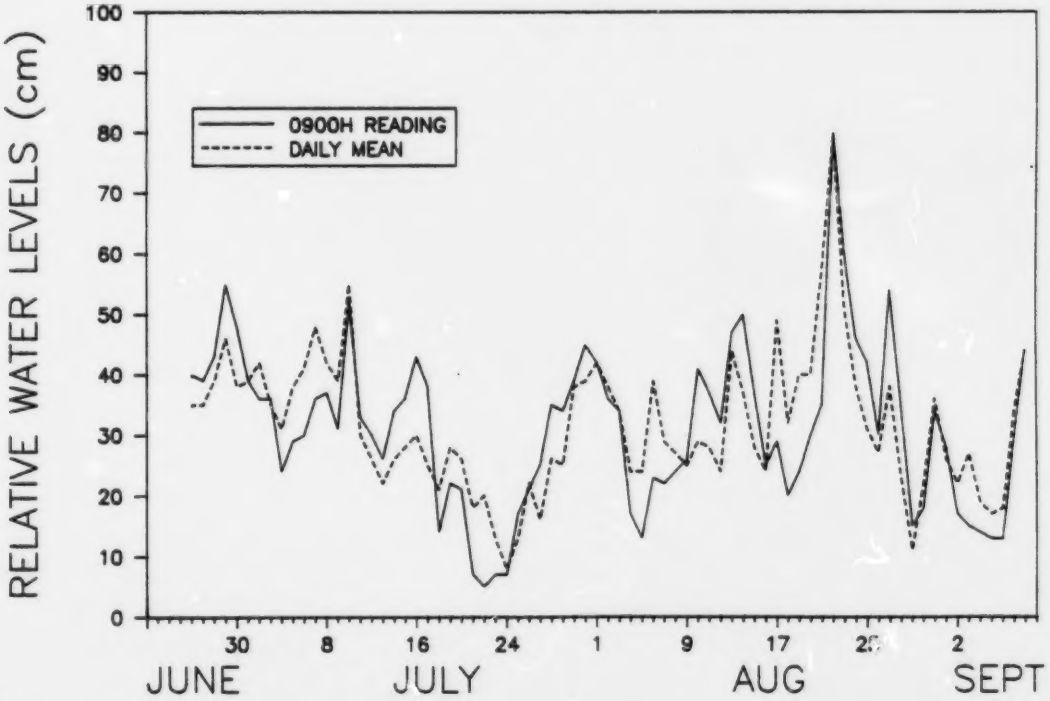

Fig. 6. Relative water levels recorded daily at Phillips Bay during 1986.

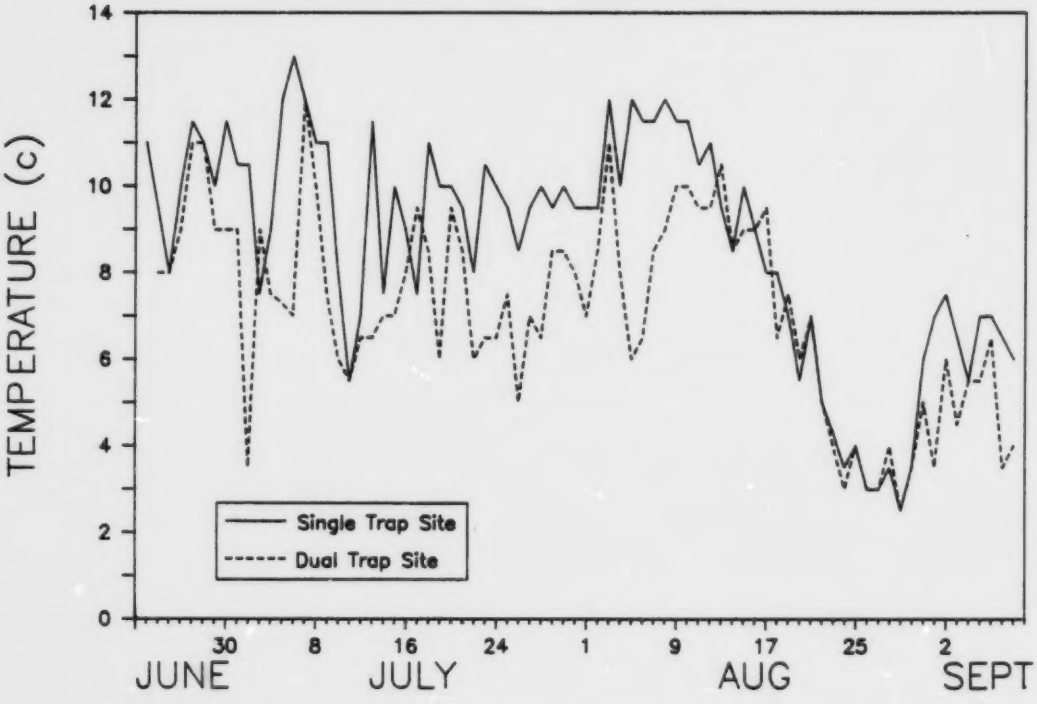

Fig. 7. Daily water temperatures recorded at trapnet locations, Phillips Bay, 1986. (Readings at 0900h).

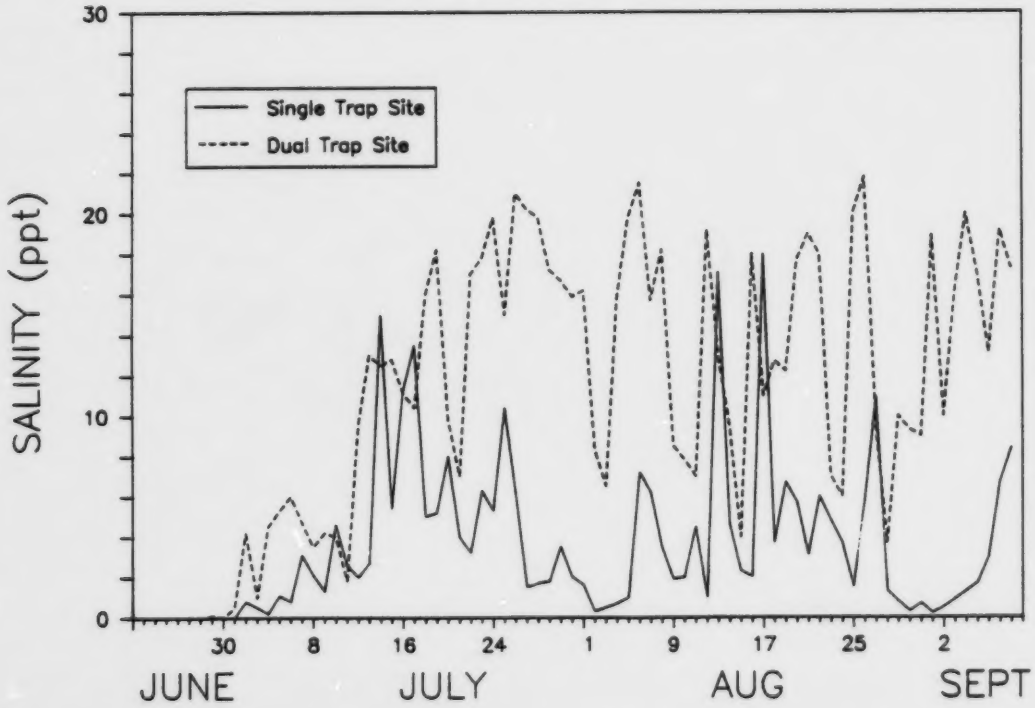

Fig. 8. Daily salinity values recorded at trapnet locations, Phillips Bay, 1986. (Readings at 0900h).

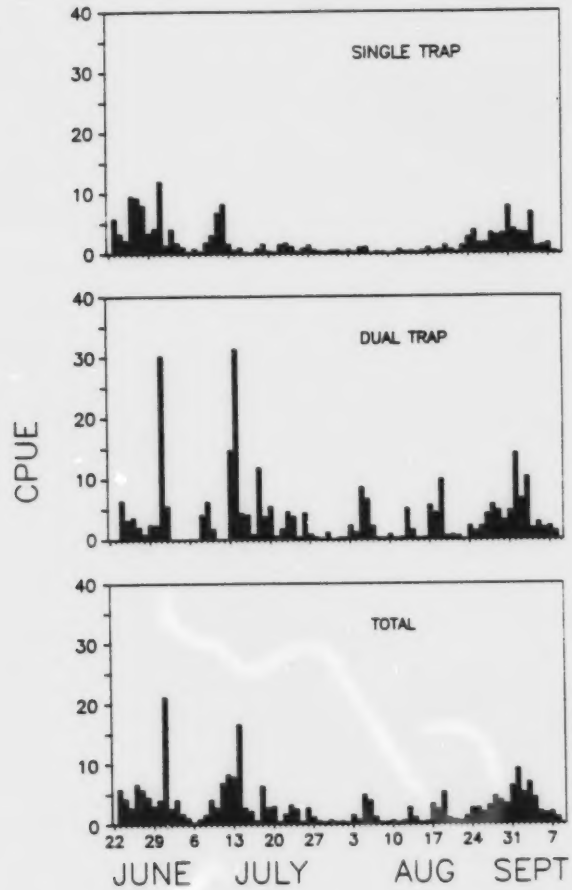

Fig. 9. Daily CPUE for large Arctic cisco in trapnets, Phillips Bay, 1986.

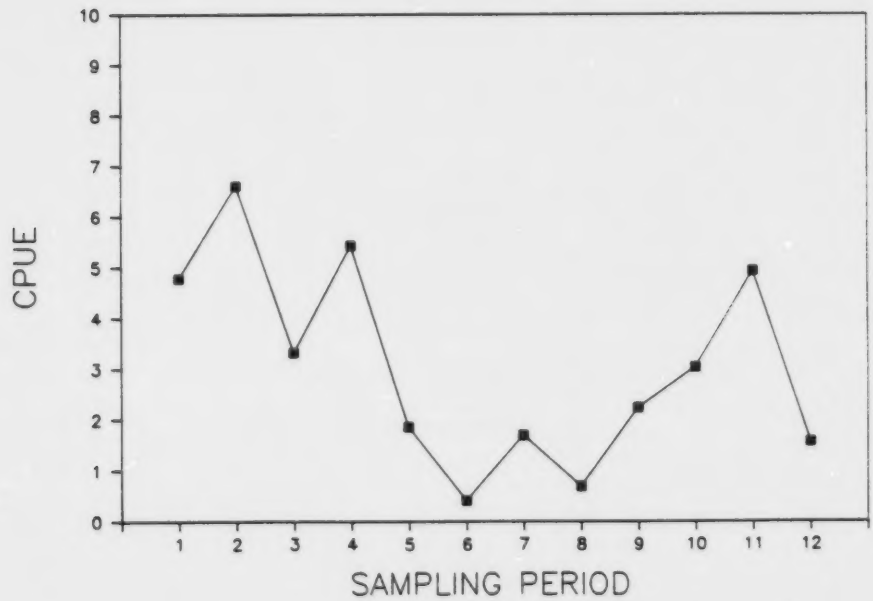

Fig. 10. Overall CPUE by sampling period for large Arctic cisco taken in trapnets, Phillips Bay, 1986.

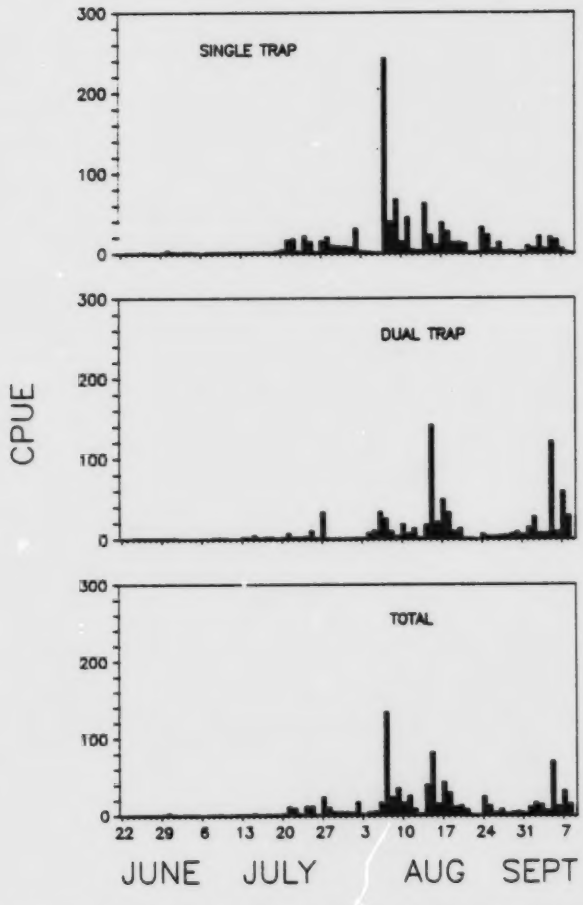

Fig. 11. Daily CPUE for small Arctic cisco in trapnets, Phillips Bay, 1986.

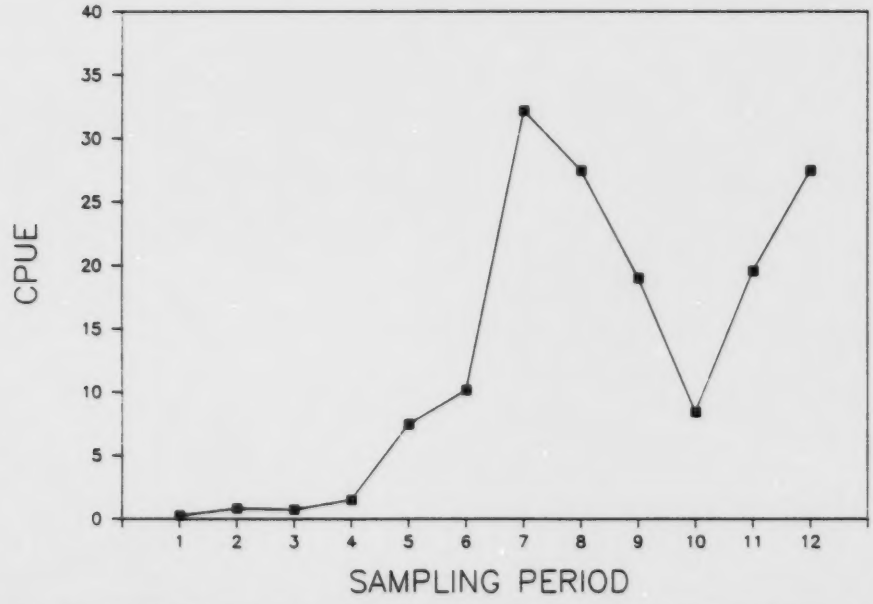

Fig. 12. Overall CPUE by sampling period for small Arctic cisco taken in trapnets at Phillips Bay, 1986.

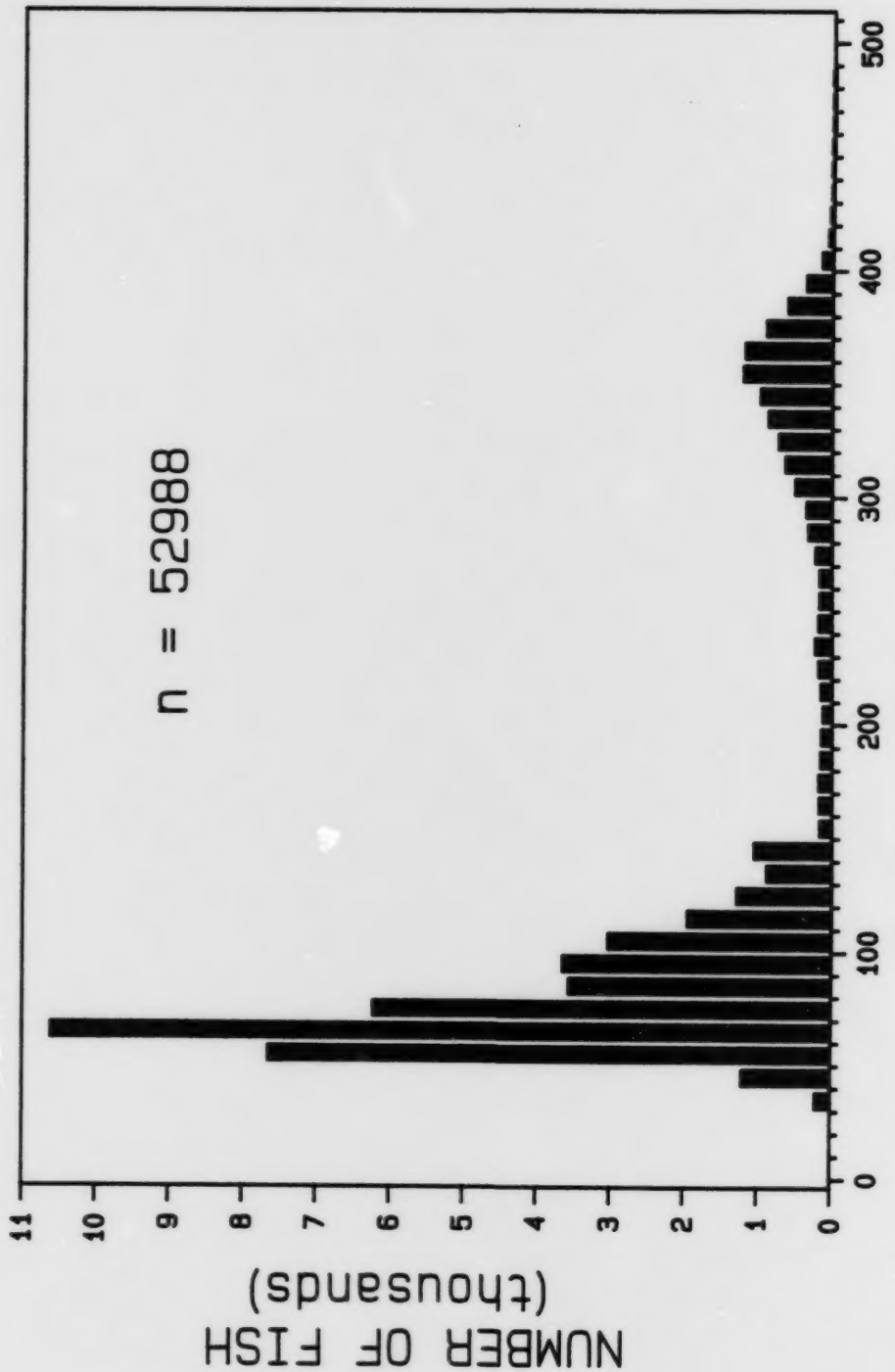

Fig. 13. Length-frequency distribution for Arctic cisco captured in trapnets at Phillips Bay, 1986.

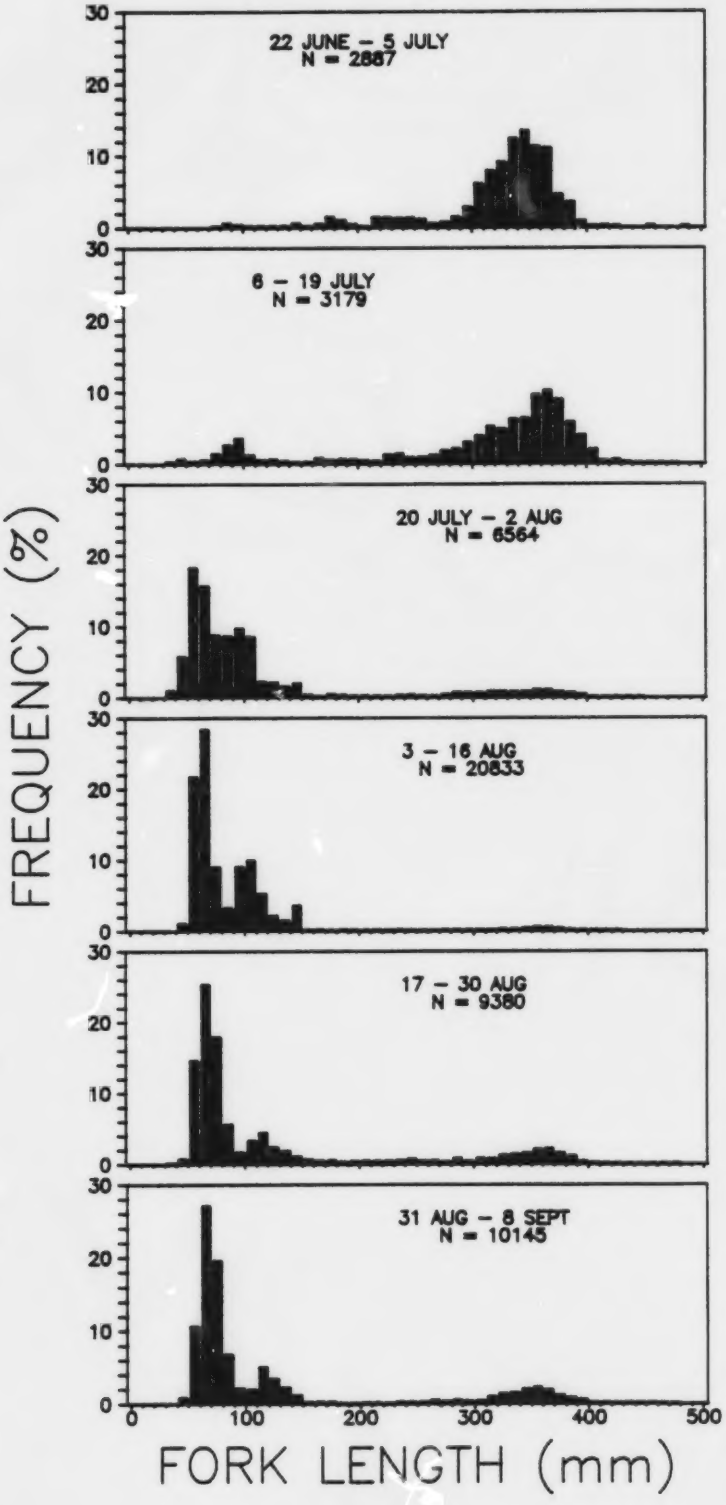

Fig. 14. Seasonal variation in length-frequency distribution of Arctic cisco captured in trapnets at Phillips Bay during summer, 1986.

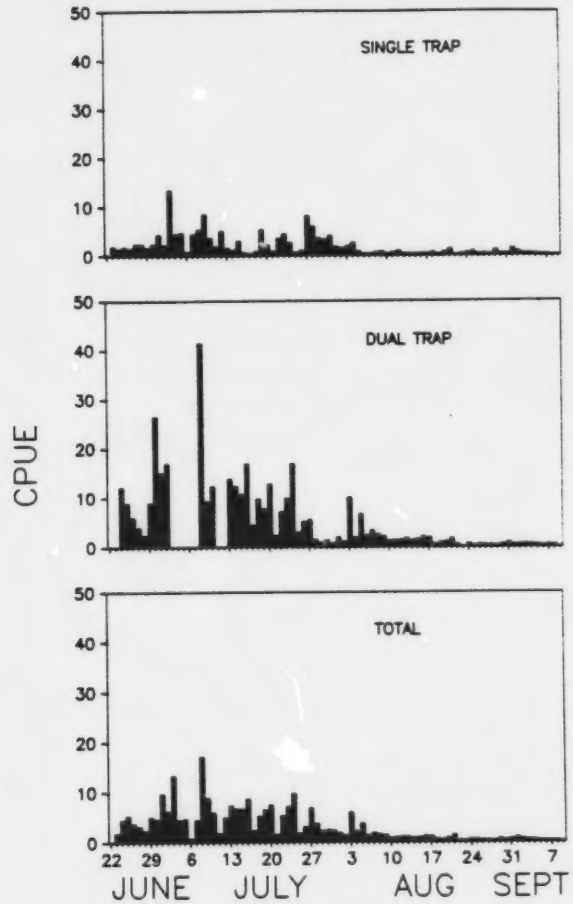

Fig. 15. Daily CPUE for large least cisco in trapnets, Phillips Bay, 1986.

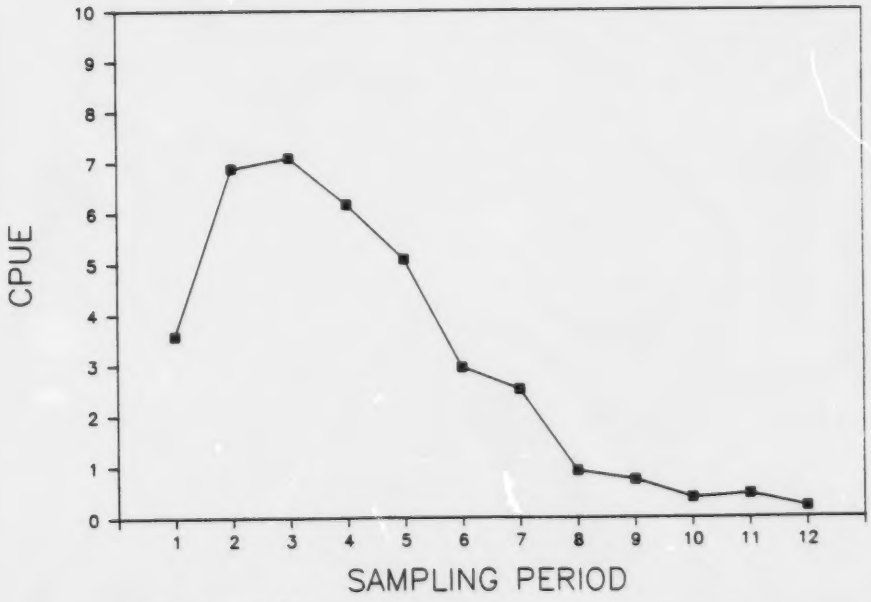

Fig. 16. Overall CPUE by sampling period for large least cisco taken in trapnets at Phillips Bay, 1986.

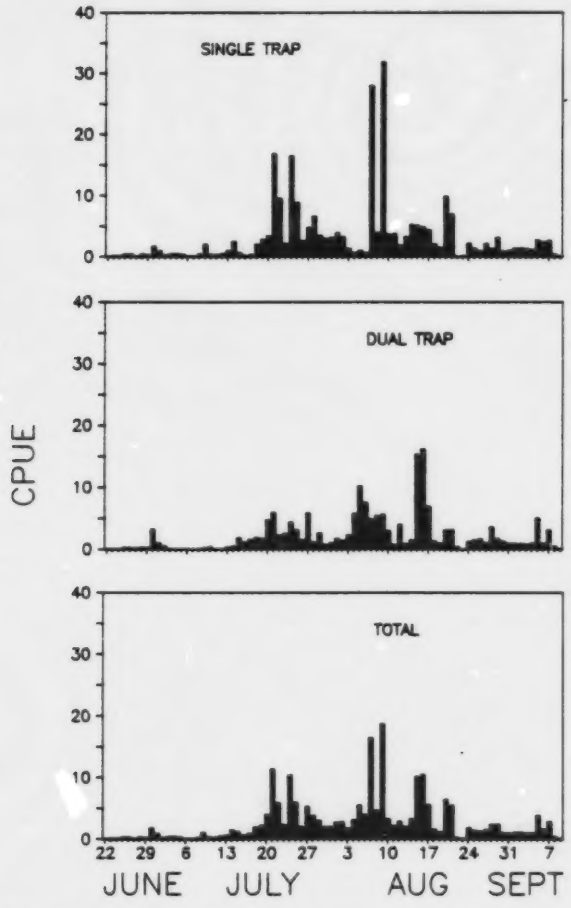

Fig. 17. Daily CPUE for small least cisco in trapnets, Phillips Bay, 1986.

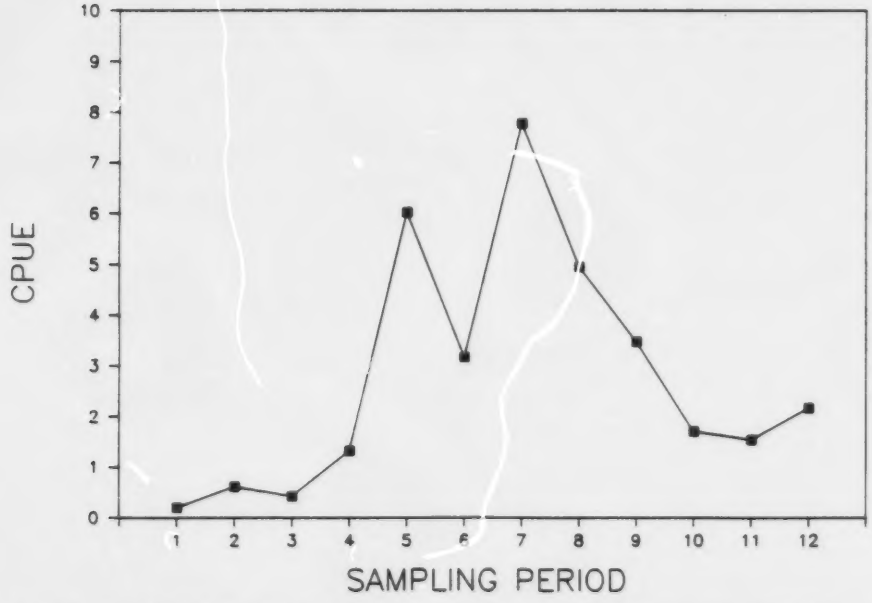

Fig. 18. Overall CPUE by sampling period for small least cisco taken in trapnets at Phillips Bay, 1986.

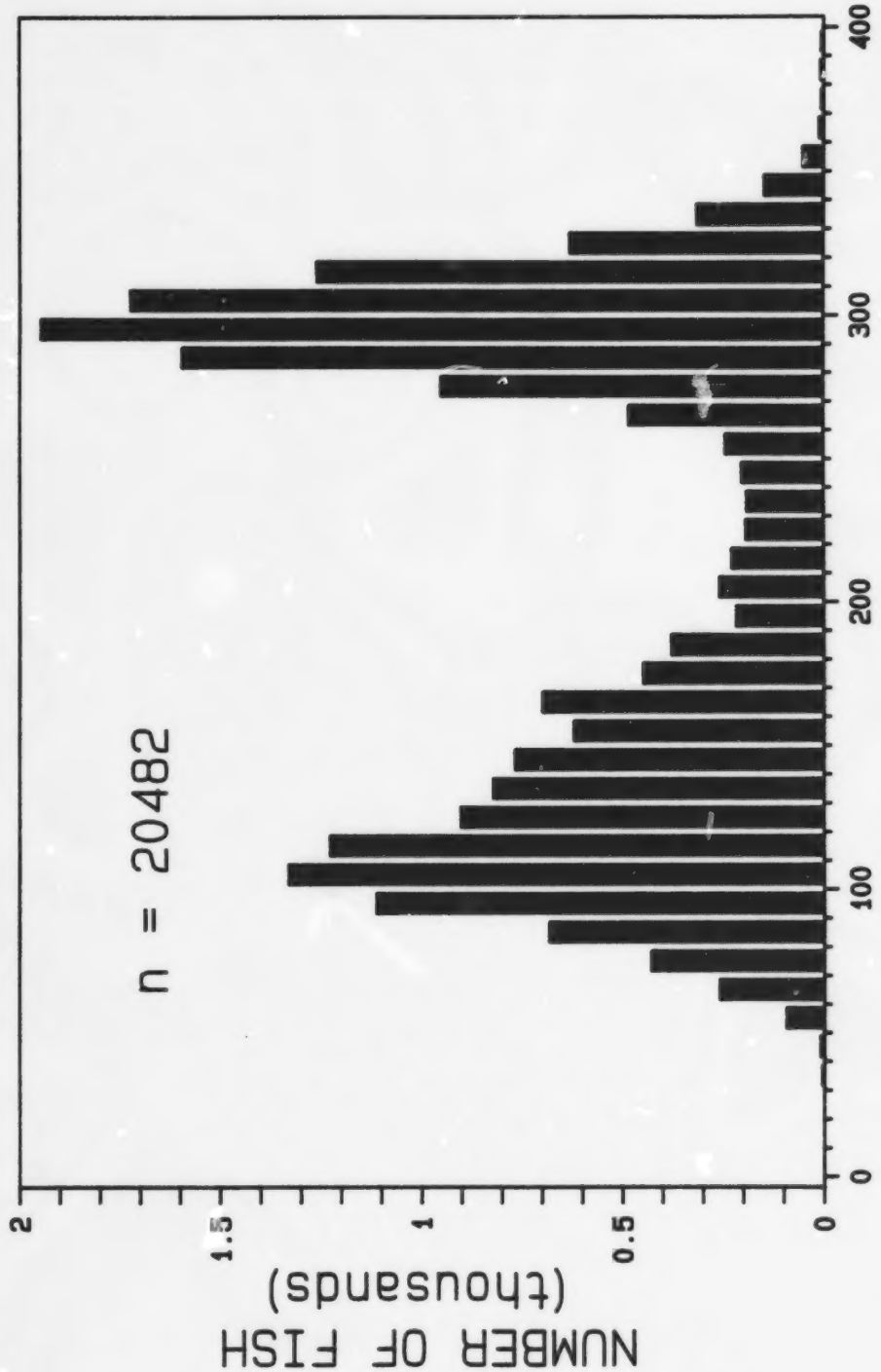

Fig. 19. Length-frequency distribution for least cisco captured in trapnets at Phillips Bay, 1986.

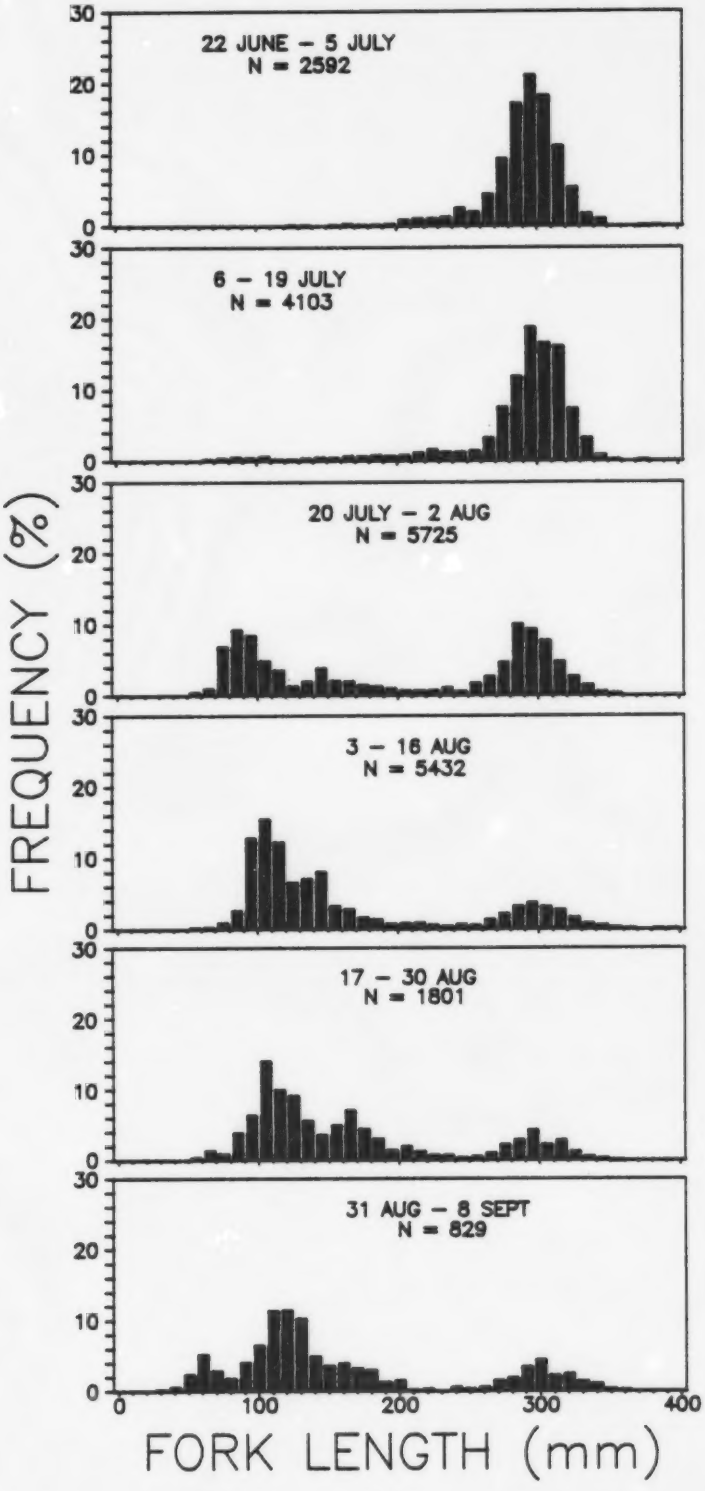

Fig. 20. Seasonal variation in length-frequency distribution of least cisco captured in trapnets at Phillips Bay during summer, 1986.

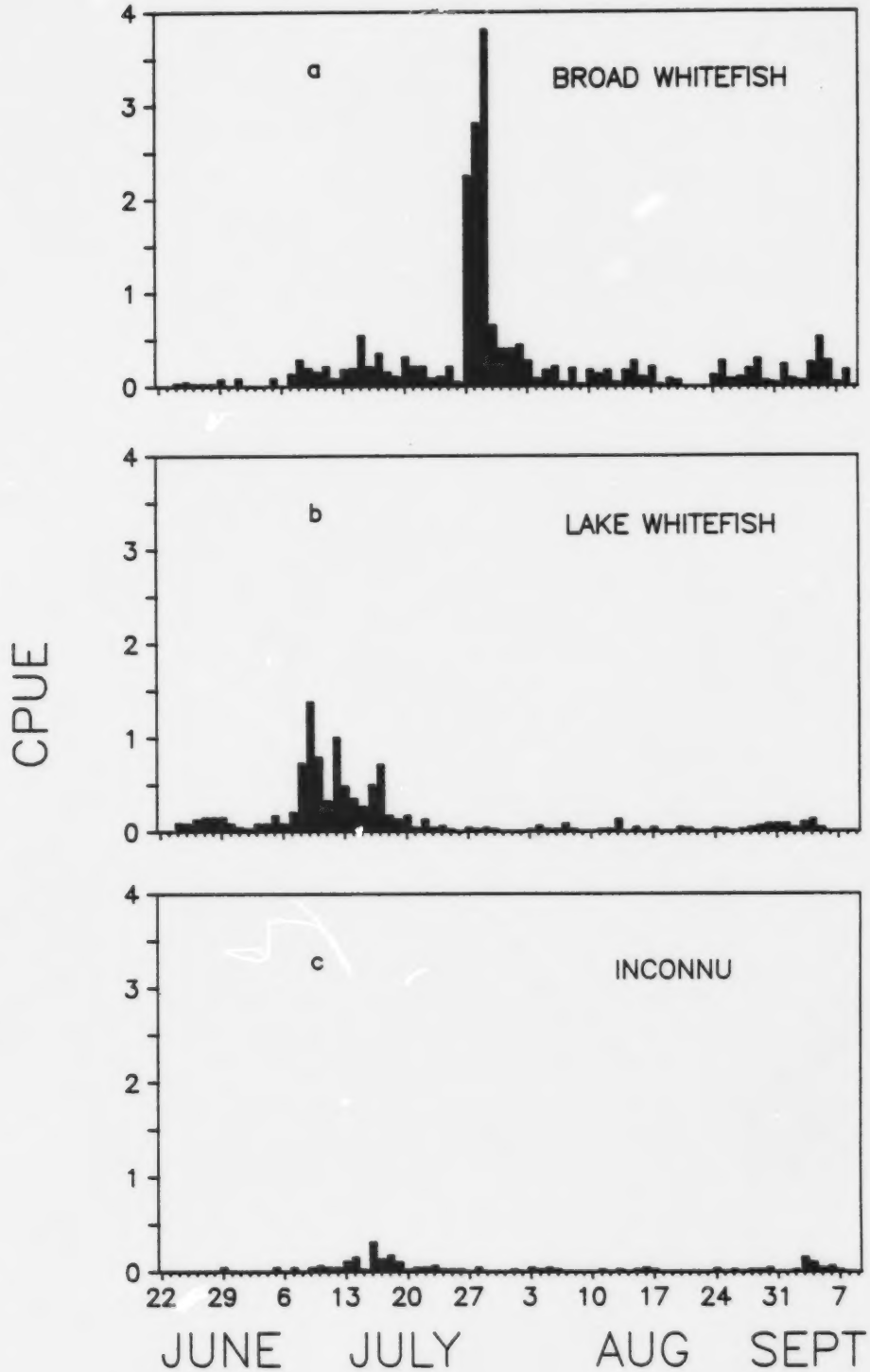

Fig. 21. Daily CPUE for broad whitefish, lake whitefish, and inconnu in trapnets, Phillips Bay, 1986.

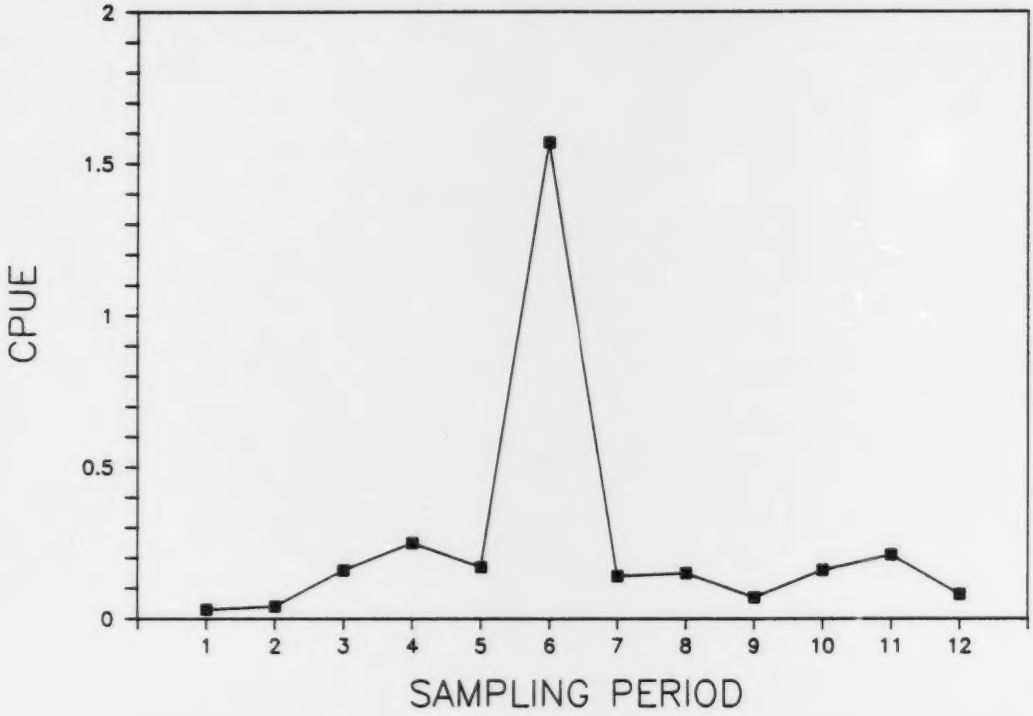

Fig. 22. Overall CPUE by sampling period for broad whitefish taken in trapnets at Phillips Bay, 1986.

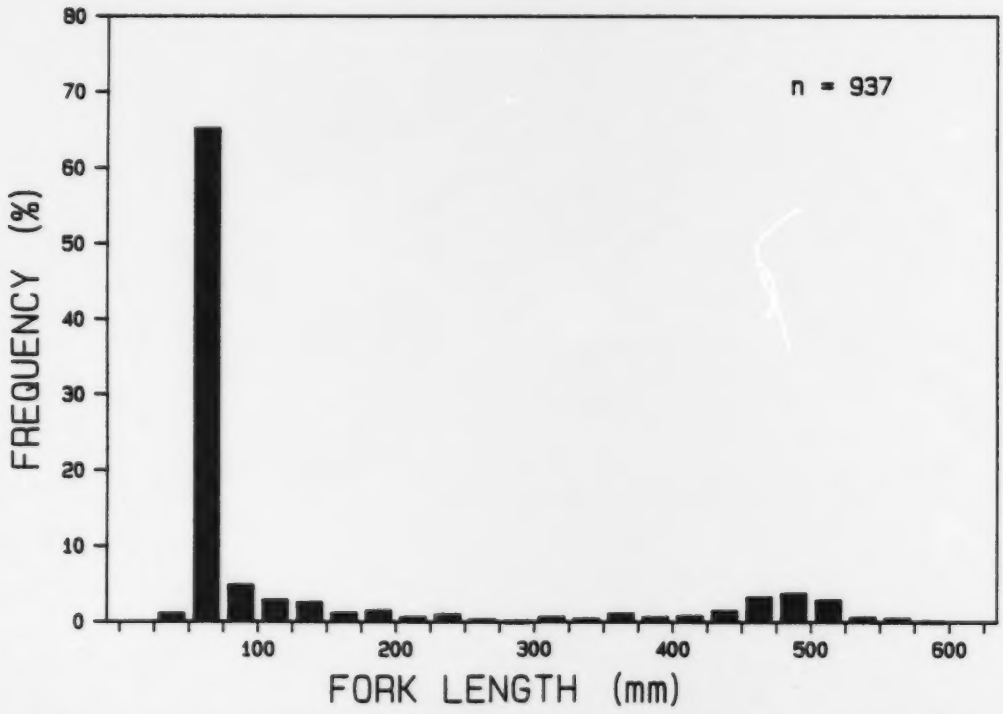

Fig. 23. Length-frequency distribution for broad whitefish captured in trapnets at Phillips Bay, 1986.

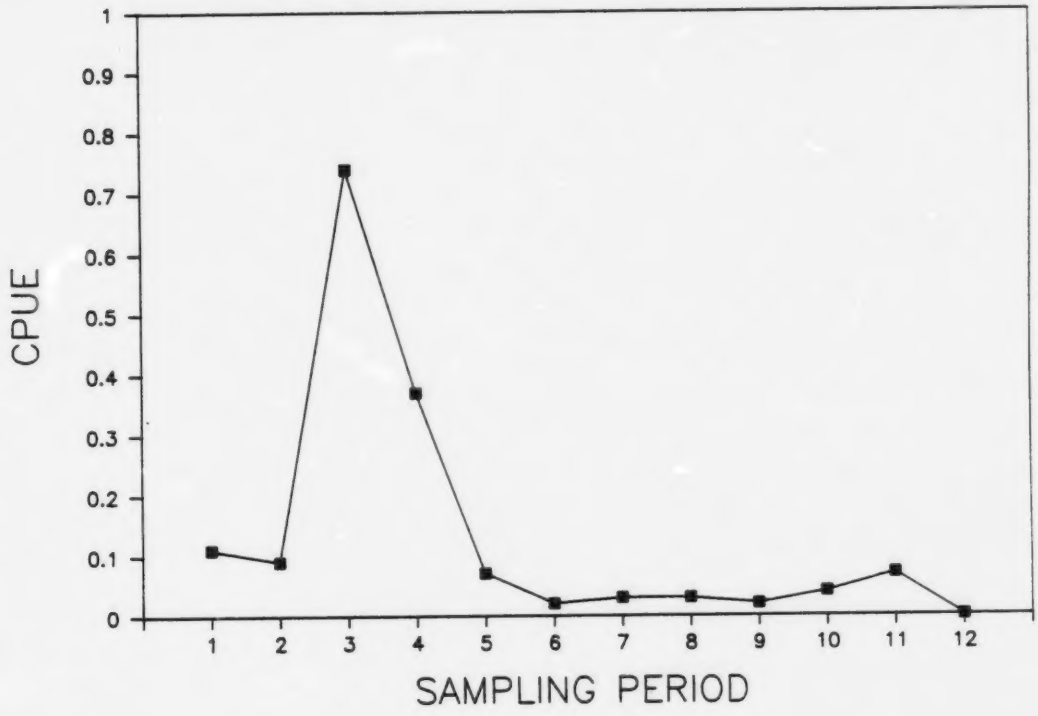

Fig. 24. Overall CPUE by sampling period for lake whitefish taken in trapnets at Phillips Bay, 1986.

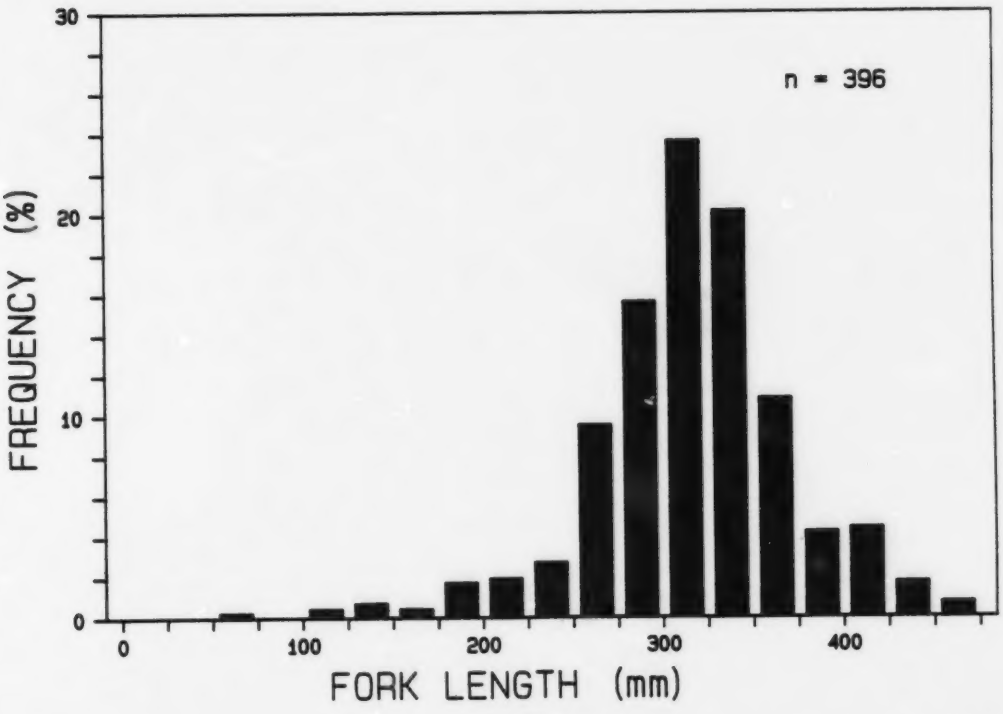

Fig. 25. Length-frequency distribution for lake whitefish captured in trapnets at Phillips Bay, 1986.

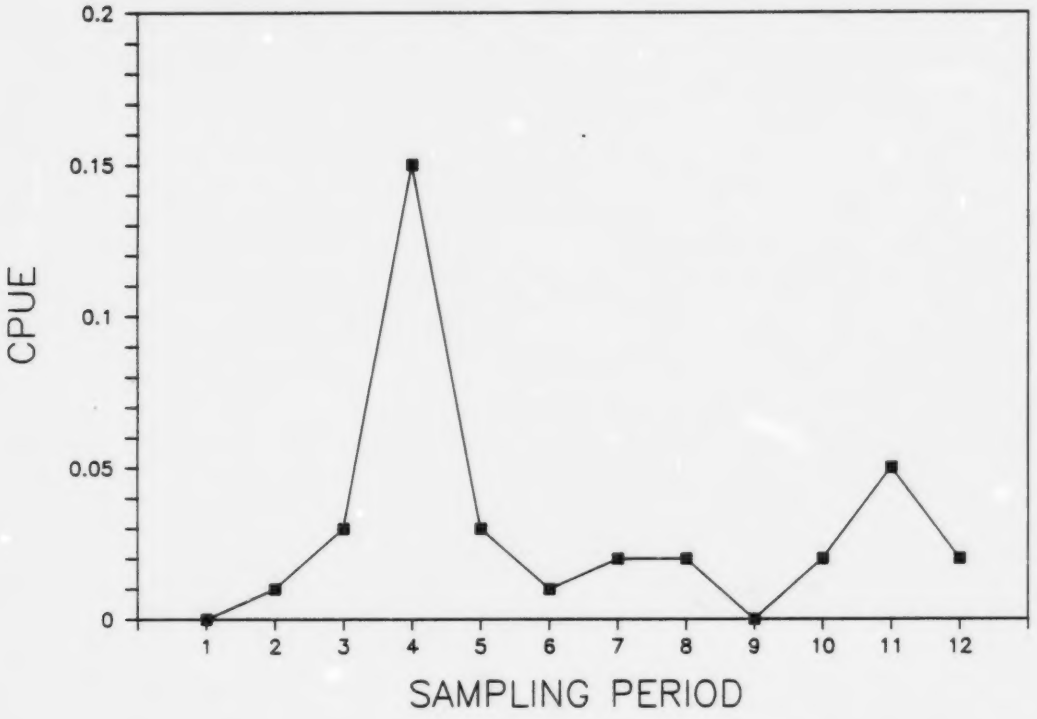

Fig. 26. Overall CPUE by sampling period for inconnu taken in trapnets at Phillips Bay, 1986.

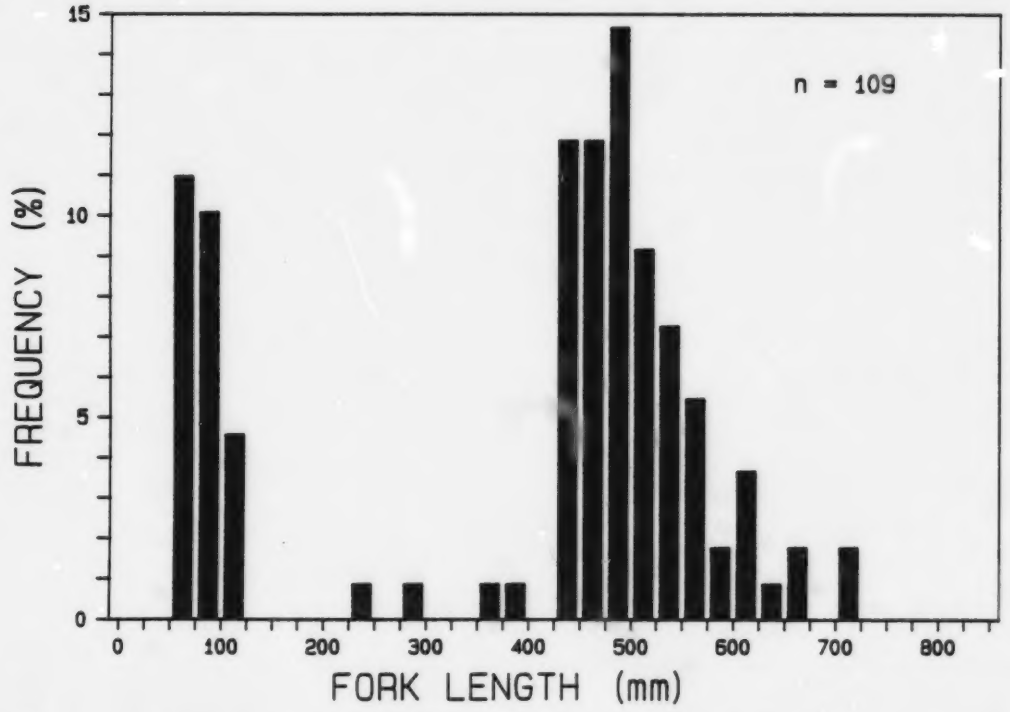

Fig. 27. Length-frequency distribution for inconnu captured in trapnets at Phillips Bay, 1986.

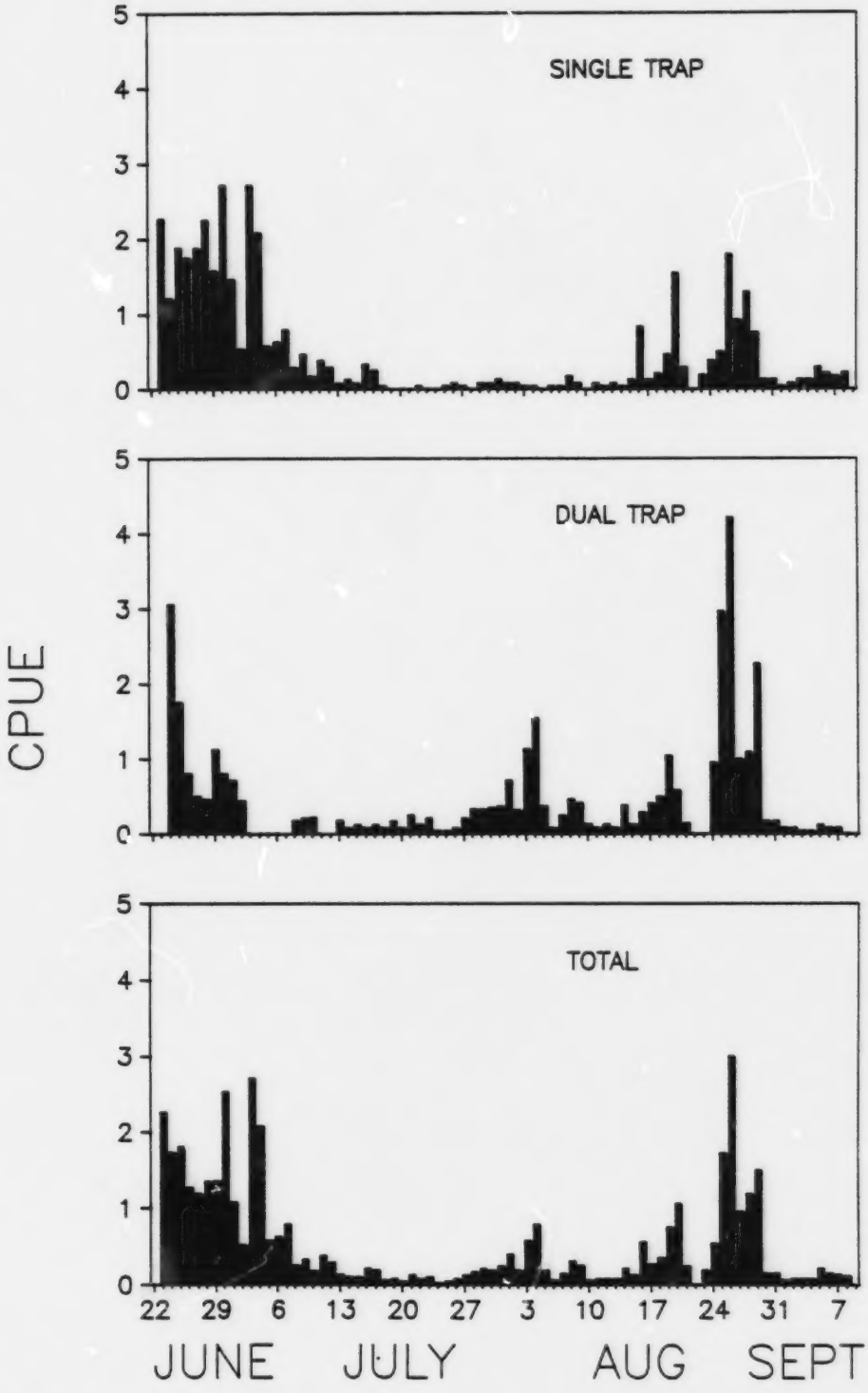

Fig. 28. Daily CPUE for Arctic charr in trapnets, Phillips Bay, 1986.

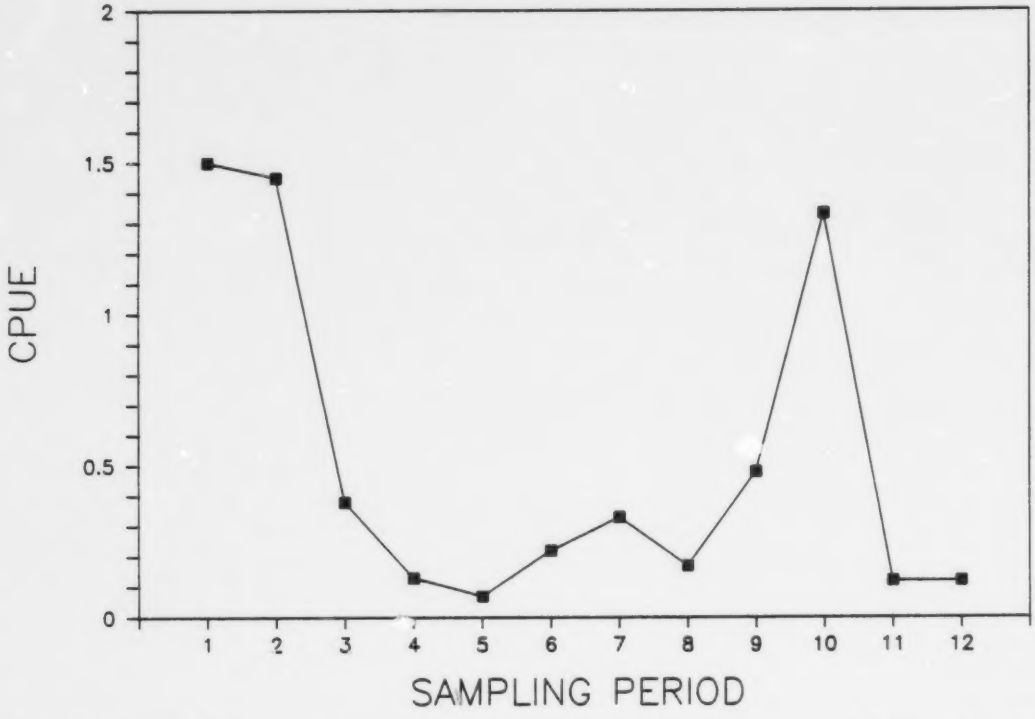

Fig. 29. Overall CPUE by sampling period for Arctic charr taken in trapnets at Phillips Bay, 1986.

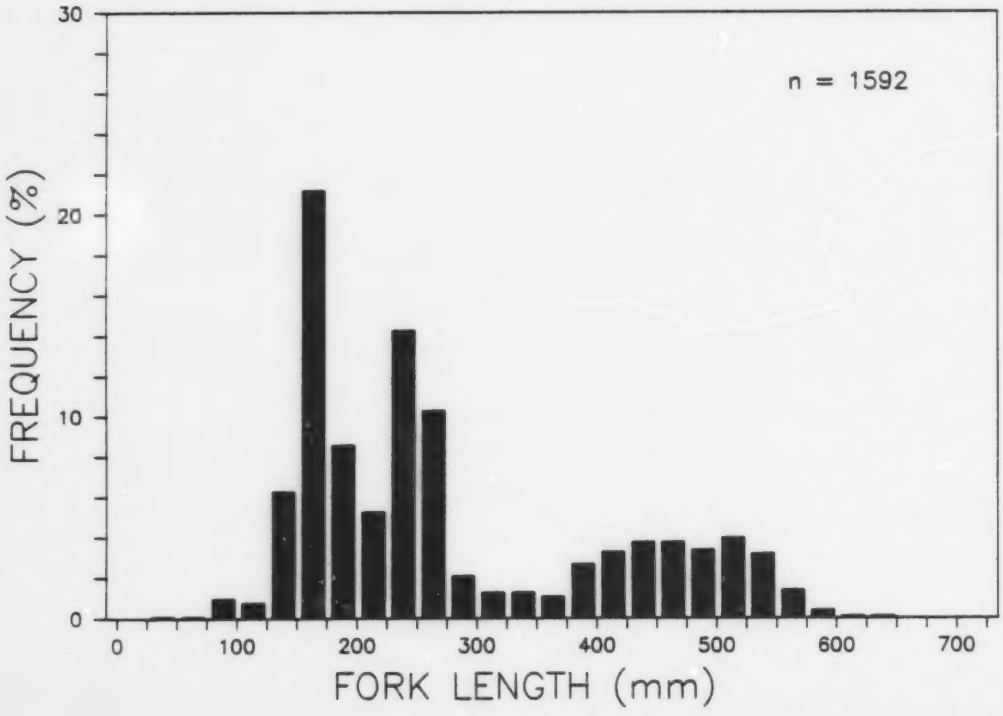

Fig. 30. Length-frequency distribution for Arctic charr captured in trapnets at Phillips Bay, 1986.

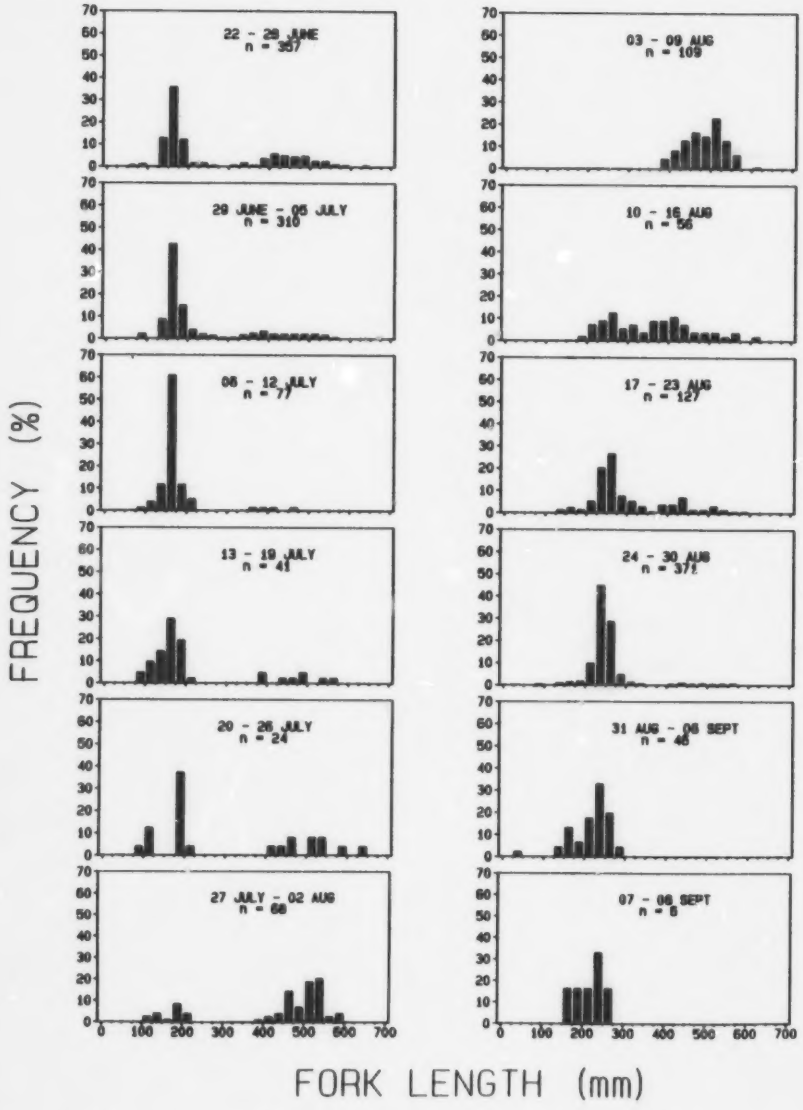

Fig. 31. Seasonal variation in length-frequency distribution of Arctic charr captured in trapnets at Phillips Bay during summer, 1986.

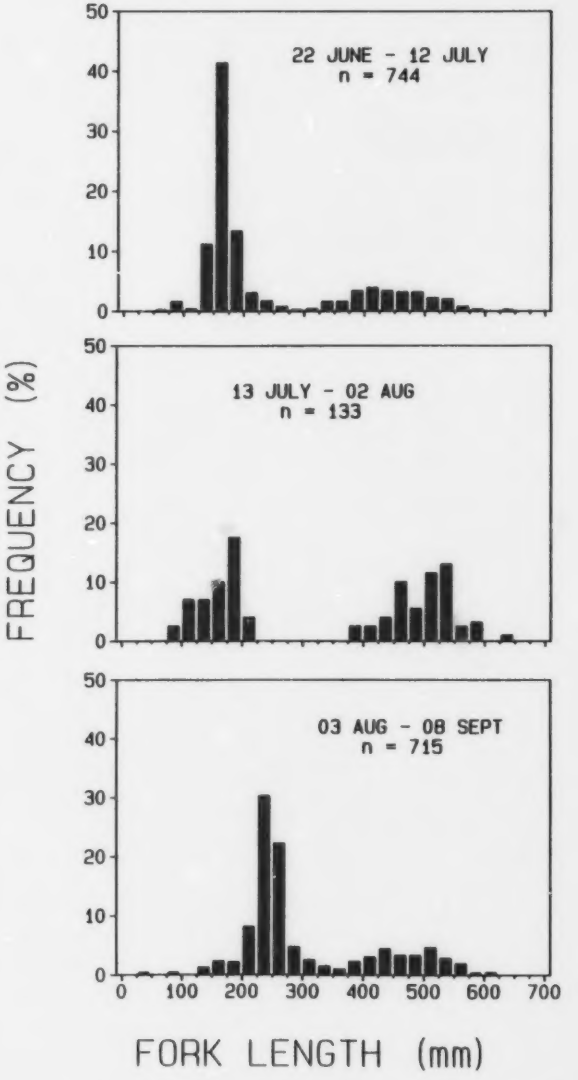

Fig. 32. Length-frequency distribution of Arctic charr pooled to emphasize differences in the size of fish captured during the early, middle, and late stages of the run in Phillips Bay, 1986.

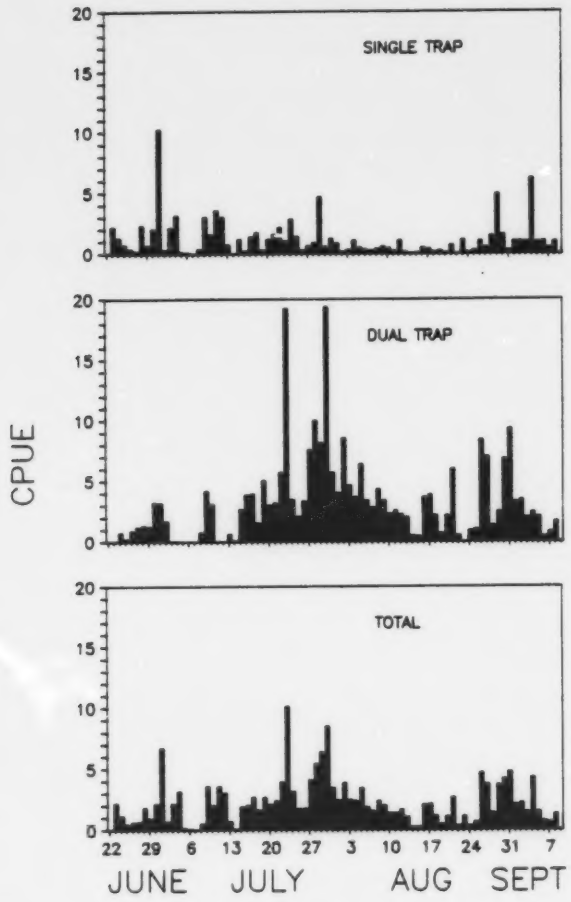

Fig. 33. Daily CPUE for rainbow smelt in trapnets, Phillips Bay, 1986.

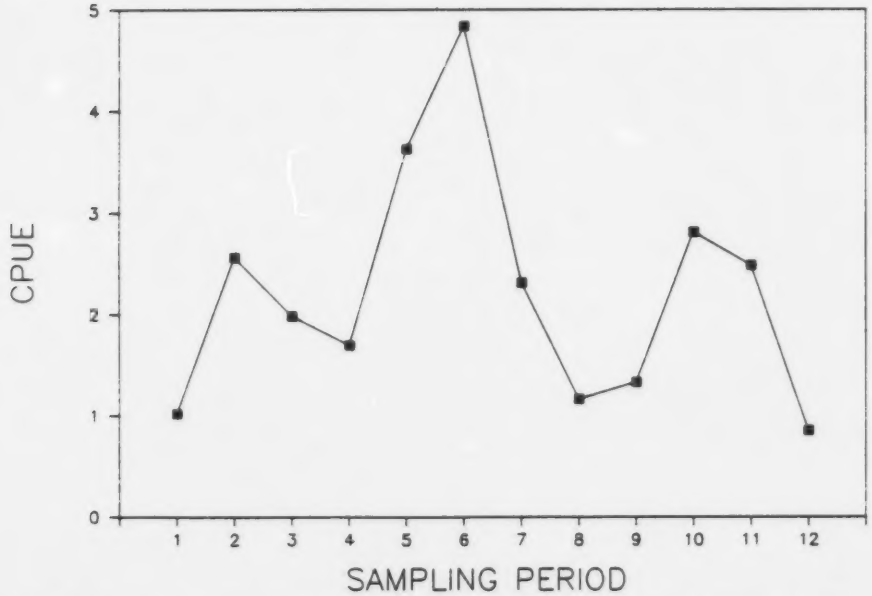

Fig. 34. Overall CPUE by sampling period for rainbow smelt taken in trapnets at Phillips Bay, 1986.

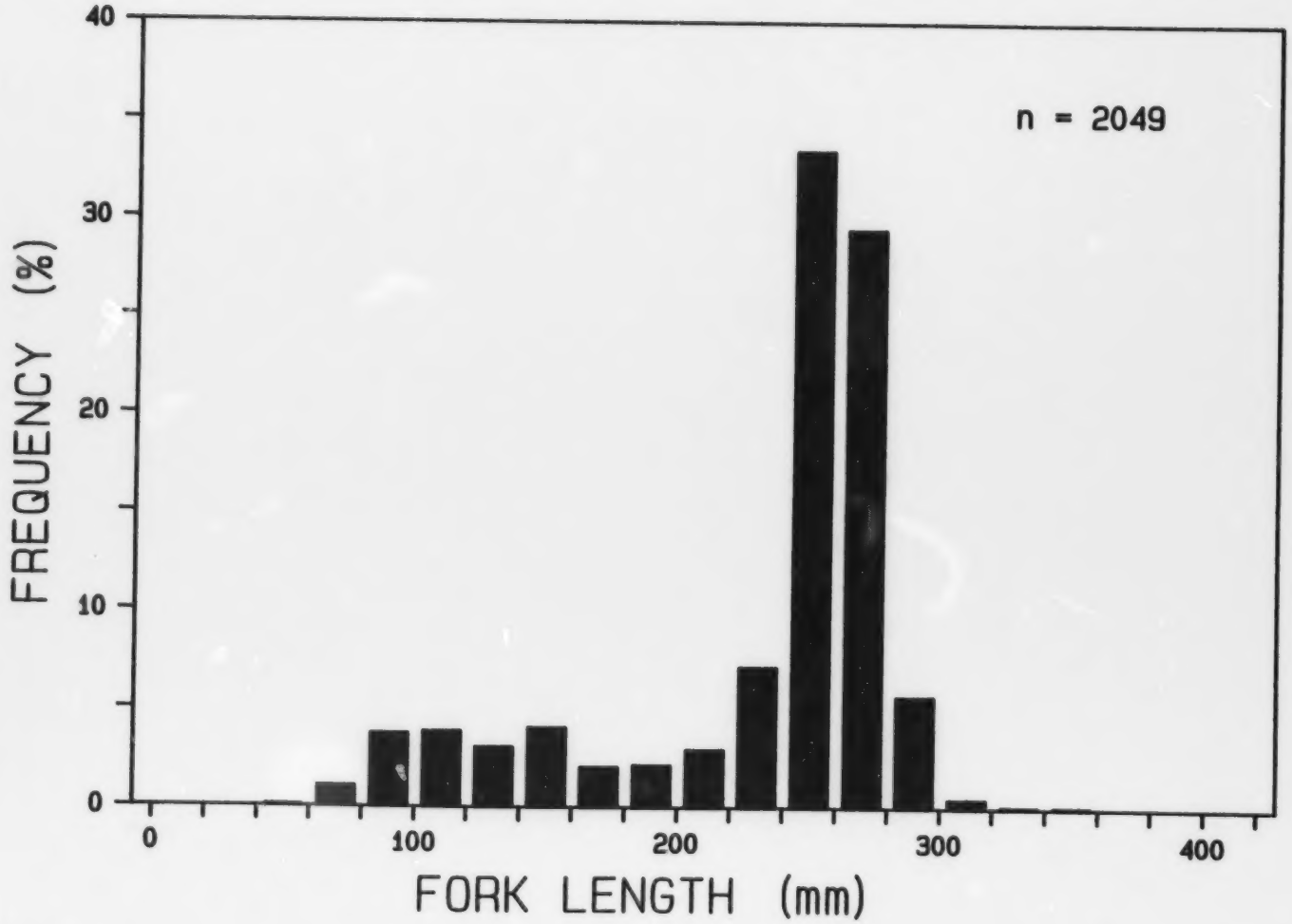

Fig. 35. Length-frequency distribution for rainbow smelt captured in trapnets at Phillips Bay, 1986.

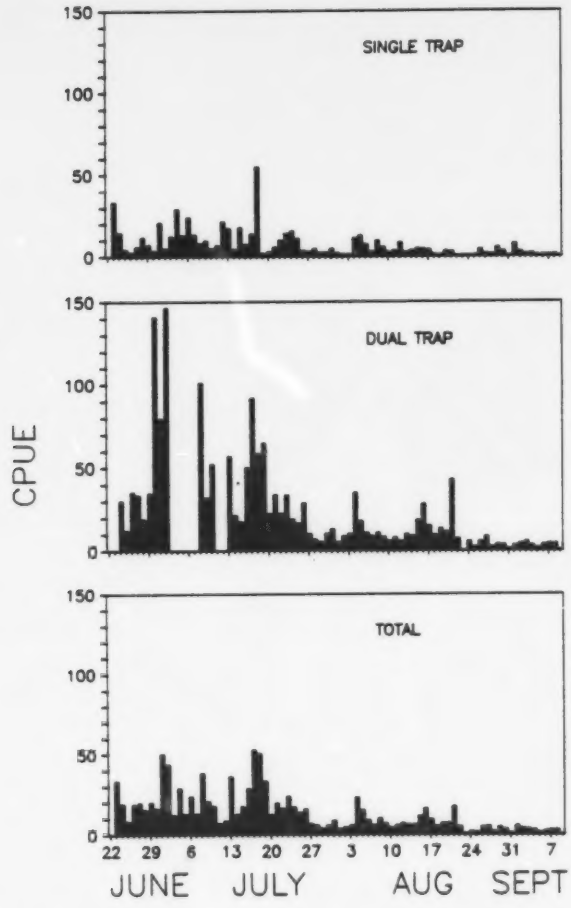

Fig. 36. Daily CPUE for Arctic flounder in trapnets, Phillips Bay, 1986.

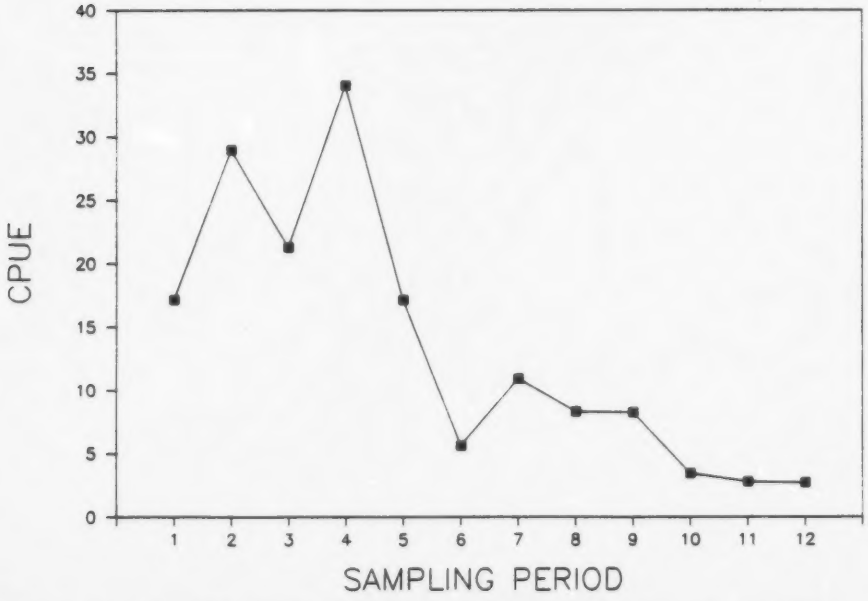

Fig. 37. Overall CPUE by sampling period for Arctic flounder taken in trapnets at Phillips Bay, 1986.

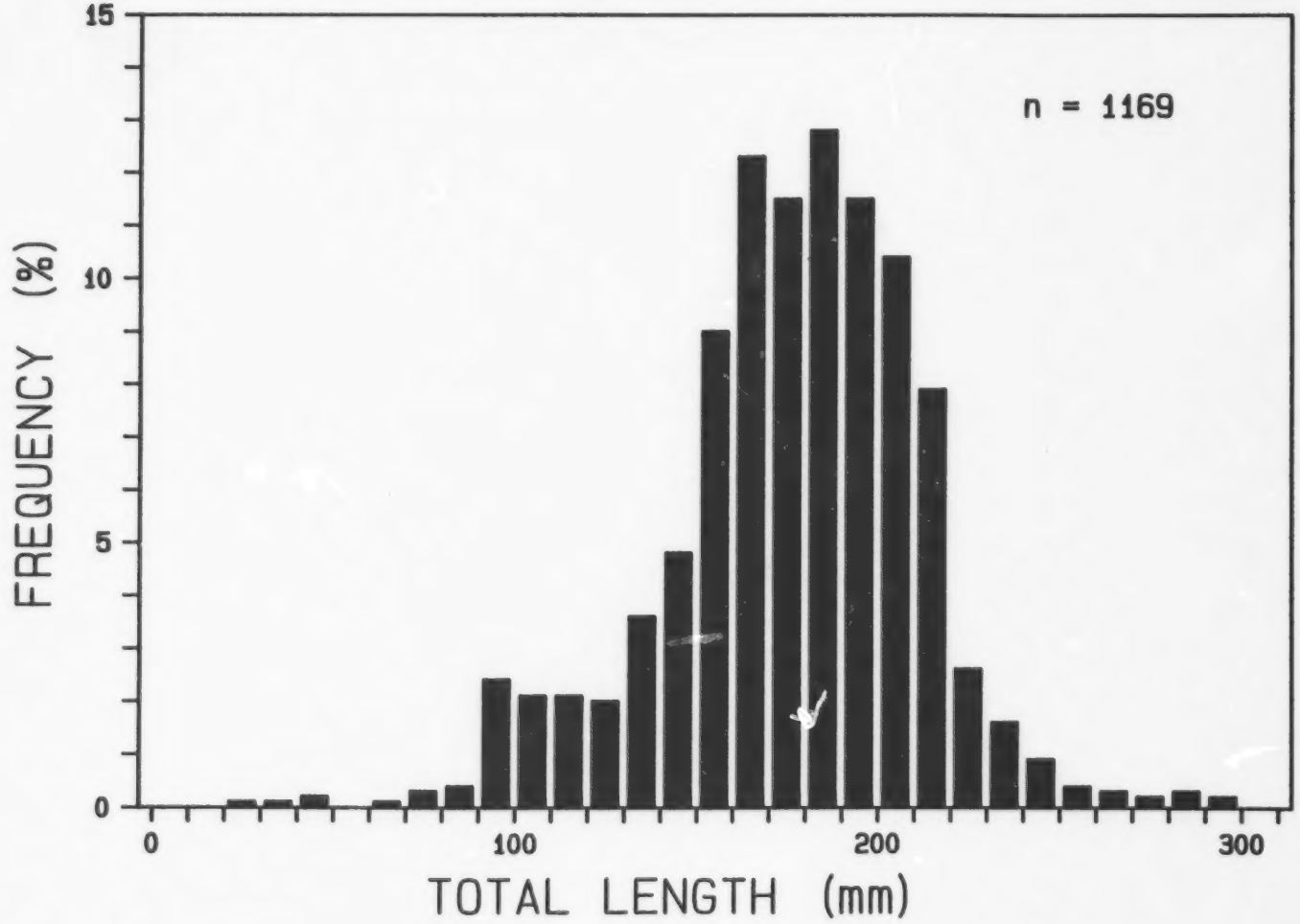

Fig. 38. Length-frequency distribution for Arctic flounder captured in trapnets at Phillips Bay, 1986.

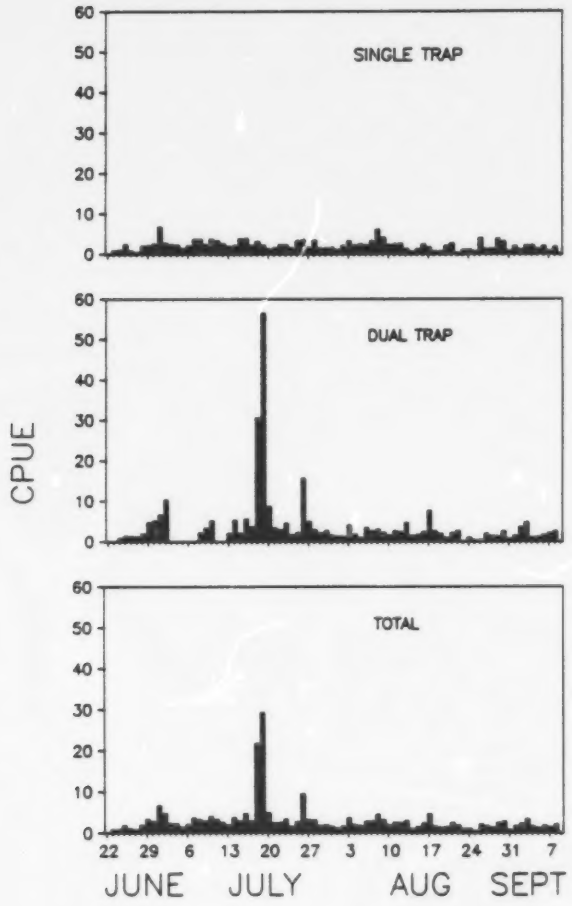

Fig. 39. Daily CPUE for fourhorn sculpin in trapnets, Phillips Bay, 1986.

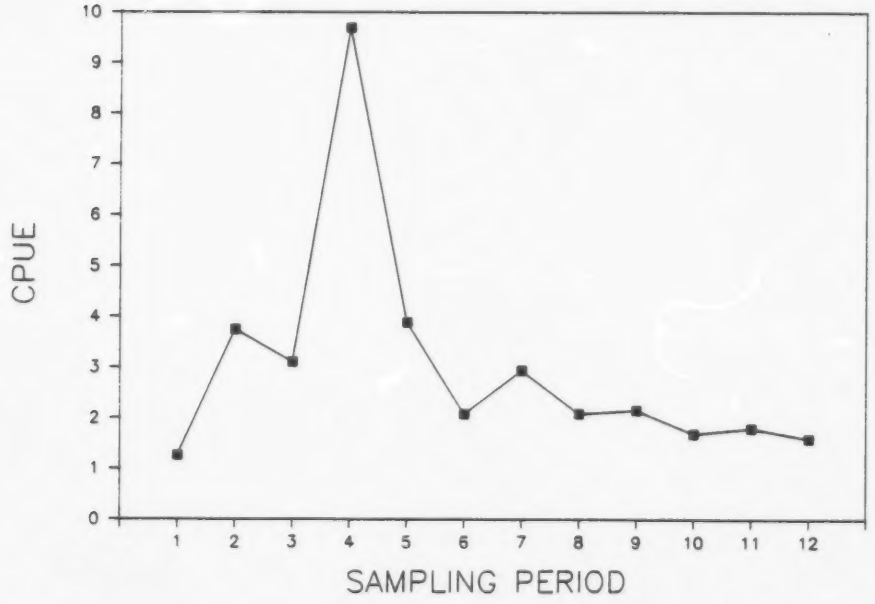

Fig. 40. Overall CPUE by sampling period for fourhorn sculpin taken in trapnets at Phillips Bay, 1986.

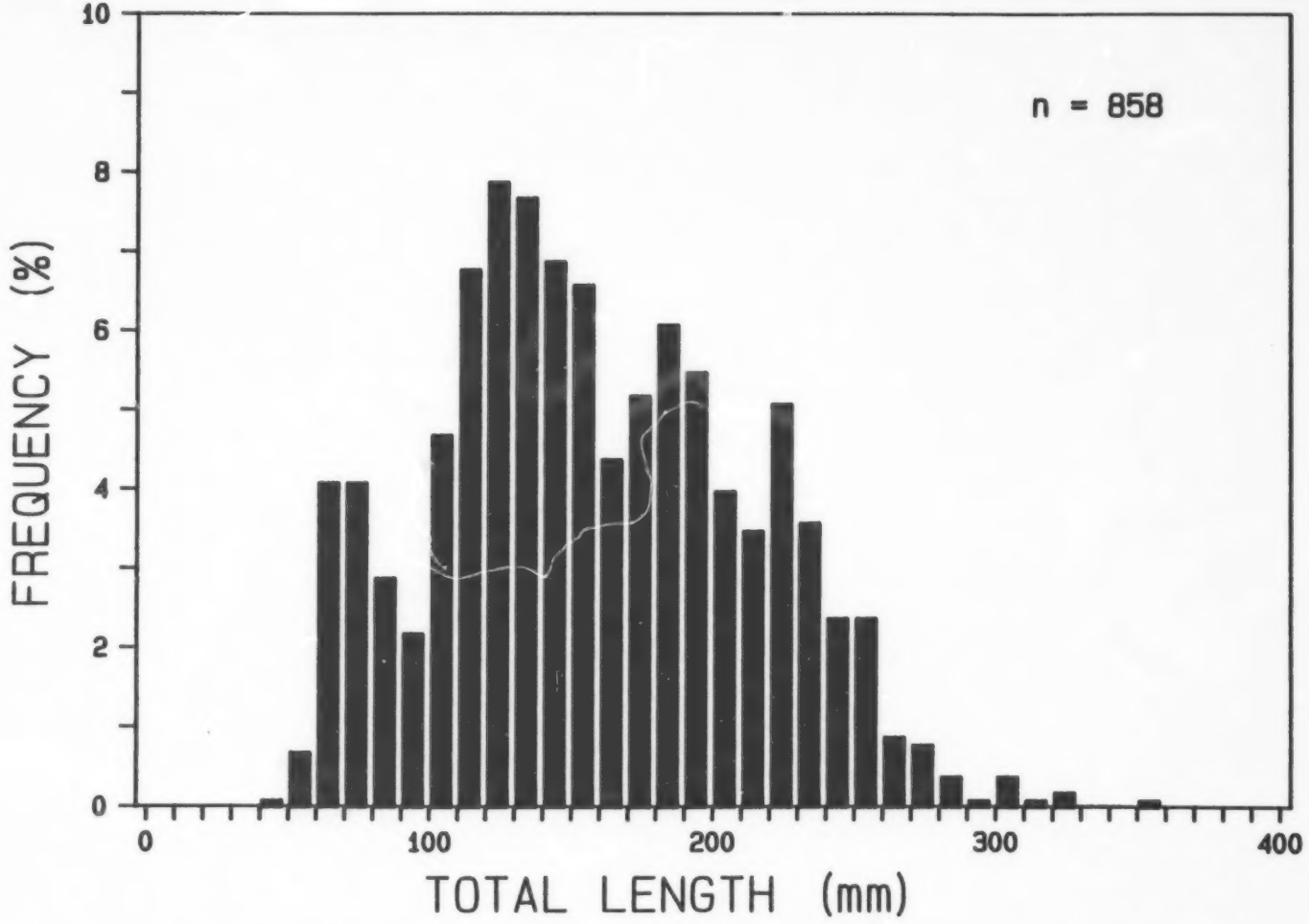

Fig. 41. Length-frequency distribution for fourhorn sculpin captured in trapnets at Phillips Bay, 1986.

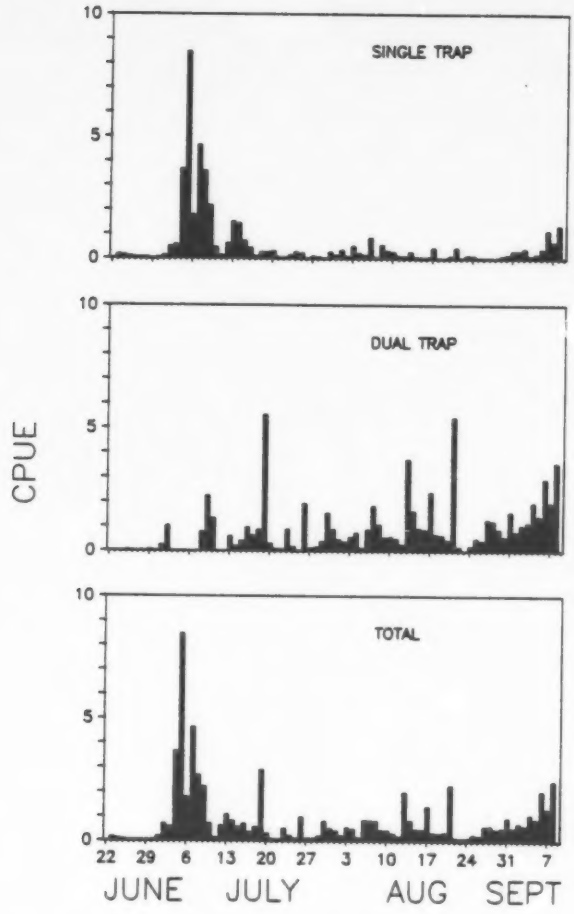

Fig. 42. Daily CPUE for saffron cod in trapnets, Phillips Bay, 1986.

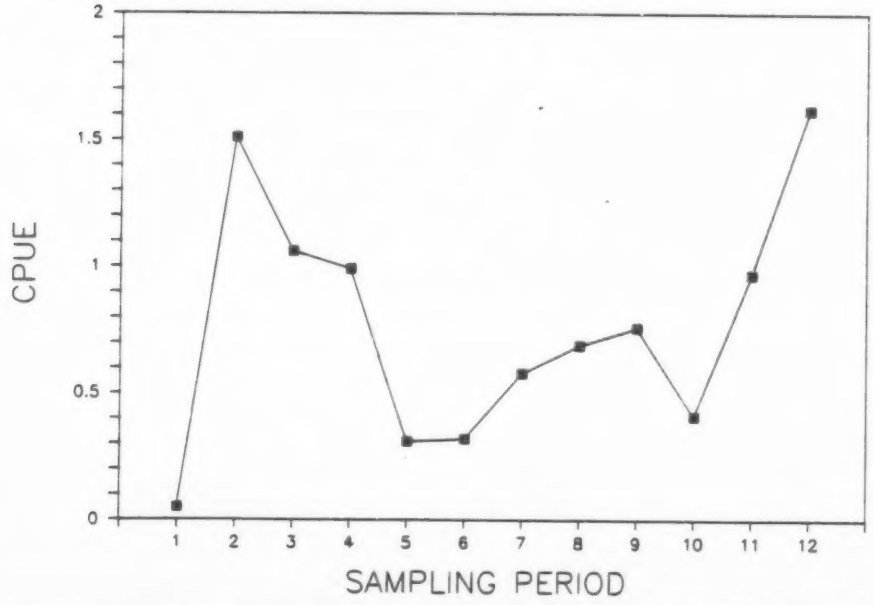

Fig. 43. Overall CPUE by sampling period for saffron cod taken in trapnets at Phillips Bay, 1986.

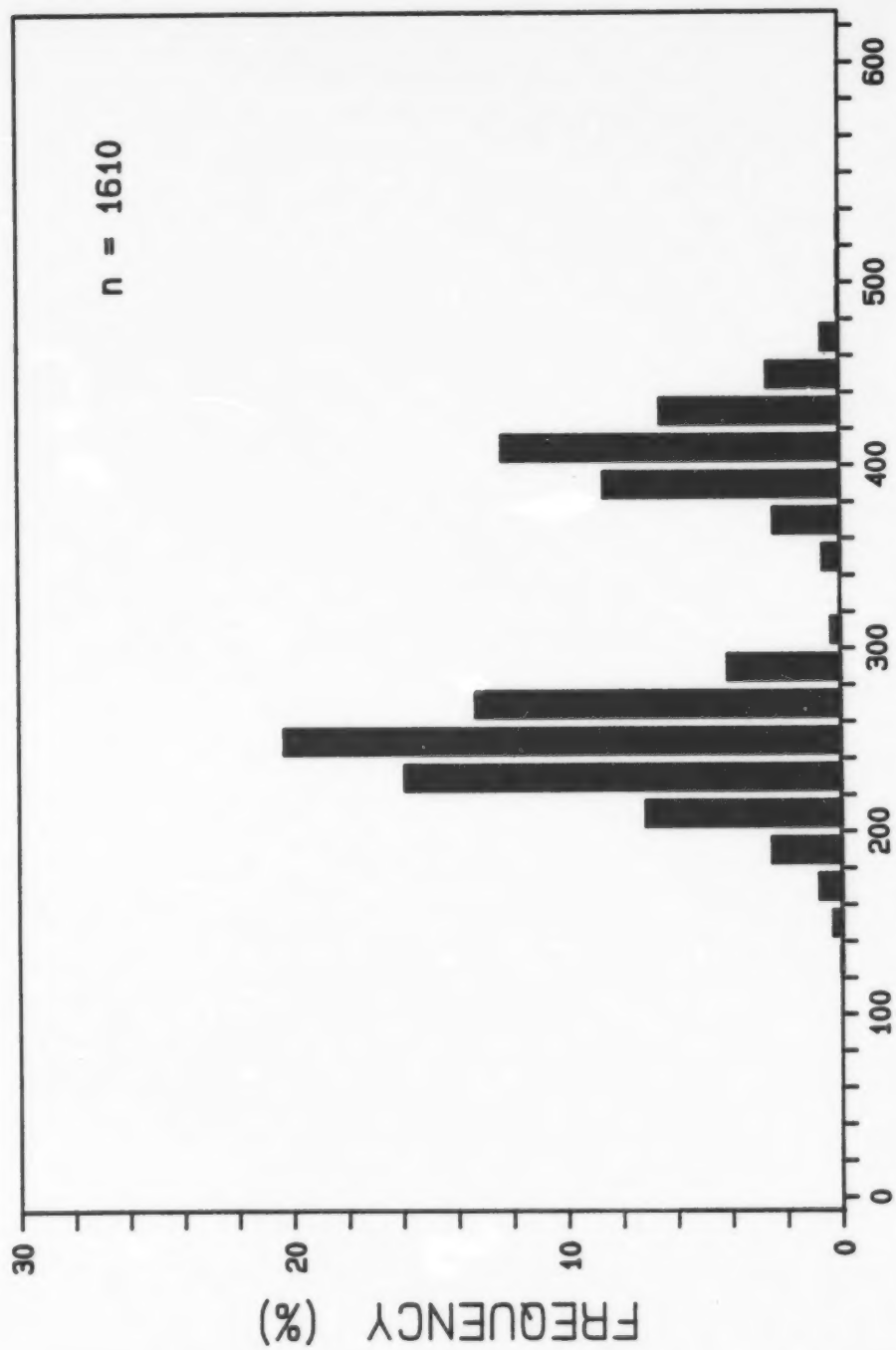

Fig. 44. Length-frequency distribution for saffron cod captured in trapnets at Phillips Bay, 1986.

Appendix A1. Salinity, conductivity, and relative water levels recorded at trap locations, Phillips Bay, 1986.

Date	Salinity (0/00)[1]		Conductivity (µS.cm^{-1})		Relative Water Level (cm)			
	Single Trap	Dual Trap	Single Trap	Dual Trap	0900	1400	1900	2400
23 June	0.0		450					
24	0.0	0.0	710	490				
25	0.0	0.0	610	420				
26	0.0	0.0	380	410	40	30	44	26
27	0.0	0.0	420	430	39	28	41	31
28	0.0	0.0	320	350	43	35	43	35
29	0.0	0.1	720	890	55	44	42	44
30	0.0		470		48	42	33	30
1 July	0.0	0.5	480	1 480	39	38		
2	0.8	4.2	1 580	5 800	36	53	41	39
3	0.5	1.0	1 500	2 160	36	45	28	29
4	0.2	4.5	950	6 000	24	45	28	28
5	1.1		1 900		29	52	38	33
6	0.8	6.0	1 100	7 000	30	55	44	35
7	3.1	4.7	4 100	5 200	36	60	52	43
8	2.1	3.5	2 460	4 080	37	49	51	30
9	1.3	4.2	1 880	5 500	31	42	48	33
10	4.6	4.0	4 910	4 330	52	72	62	35
11	2.6	1.8	3 000	2 100	33	29	40	17
12	2.0	9.5	2 530	11 700	30	27	32	15
13	2.7	13.0	3 680	17 400	26	18	26	16
14	15.0	12.5	16 300	14 900	34	23		22
15	5.4	12.8	7 500	16 500	36	22	25	27
16	11.2	11.1	16 200	16 000	43	32	24	21
17	13.5	10.4	18 000	14 000	38	31	15	15
18	5.0	16.0	6 200	18 100	14	27	15	25
19	5.2	18.2	6 600	24 600	22	45	21	25
20	8.0	9.8	10 400	12 500	21	44	22	17
21	4.0	7.0	5 200	5 120	7	33	21	12
22	3.2	17.0	4 000	19 500	5	33	28	13
23	6.3	17.8	8 100	21 100	7	17	23	4
24	5.3	19.8	7 100	23 600	7	6	20	0
25	10.4	15.0	12 900	18 000	17	5	18	2
26	6.2	21.0	8 000	24 000	21	16	36	15
27	1.5	20.2	2 100	26 000	25	12	19	7
28	1.7	19.8	2 310	23 900	35	23	27	18
29	1.8	17.2	2 400	22 000	34	24	24	17
30	3.5	16.7	4 500	19 000	39	51	29	33
31	2.0	15.9	2 570	19 000	45	38	36	36
1 August	1.6	16.2	2 510	21 000	42	53	36	35
2	0.3	8.3	730	11 200	36	49	30	35
3	0.5	6.5	750	8 000	34	45	28	27
4	0.7	15.8	1 190	21 200	17	37	23	19
5	1.0	19.8	1 810	28 200	13	37	26	20
6	7.2	21.5	11 000	30 900	23	48	49	37
7	6.2	15.7	8 000	19 750	22	42	31	22
8	3.5	18.2	4 520	23 100	24	33	34	15
9	1.9	8.5	2 700	11 500	26	23	33	16
10	2.0	7.8	1 940	12 300	41	24	35	16
11	4.5	7.0	5 800	8 700	37	28	31	15
12	1.0	19.2	1 630	25 000	32	19	28	17
13	17.1	12.9	21 900	17 100	47	42	48	38
14	4.6	9.5	6 500	13 000	50	38	31	28
15	2.3	4.0	3 000	5 000	37	33	23	20
16	2.0	18.0	2 400	20 900	25	32	18	22
17	18.0	11.0	25 000	16 000	29	64	50	52
18	3.7	12.0	5 400	17 000	20	49	28	32
19	6.7	12.2	7 200	14 000	24	59	43	33
20	5.7	17.7	6 500	21 000	30	49	42	37
21	3.1	19.0	3 770	21 900	35	58		78
22	6.0	18.0	7 400	20 500	80			
23		7.0[2]	5 000[2]	7 500[2]			63	39
24	3.7	6.0	3 930	4 330	46	37	45	25
25	1.5	20.0	2 000	23 000	42	29	35	19
26	5.8	21.8	6 100	20 000	30	20	30	27
27	10.9	9.4	12 900	11 100	54	38	34	27
28	1.3	3.7	1 600	4 180	35	23	20	15
29	0.8	10.0	1 000	12 000	15	10		7
30	0.3	9.3	470	12 200	18	28	17	25
31	0.7	9.0	900	11 700	34	48	28	35
1 September	0.2	18.9	428	21 800	28	40	19	17
2	0.5	10.0	800	11 000	17	33	19	17
3	0.9	16.1	1 020	19 500	15	41	29	21
4	1.3	20.0	1 890	28 100	14	28	15	17
5	1.7	17.1	2 490	23 000	13	15	31	7
6	3.0	13.0	4 000	15 000	13	22	25	12
7	6.7	19.2	9 500	26 000	30	36	43	26
8	8.4	17.3	11 900	23 800	44			

[1]Recorded at 0900 h except as indicated.
[2]Recorded at 1900 h.

Appendix A2. Water temperatures (°C) recorded at each trap net location by date and time of day[1], Phillips Bay, 1986.

Date	Single Trap (Inside Niakolik Point)				Dual Trap (Outside Niakolik Point)			
	0900	1400	1900	2400	0900	1400	1900	2400
23 June	11.0							
24	9.5				8.0		8.0	
25	8.0				8.0			
26	10.0	11.0	13.0	12.0	9.0	12.0	13.0	12.0
27	11.5	11.5	11.5	12.0	11.0	11.0	11.0	11.0
28	11.0	12.5	13.5	13.5	11.0	13.5	13.5	13.0
29	10.0	12.0	12.5	12.0	9.0	12.0		
30	11.5	12.0	11.5	12.5				9.0
1 July	10.5	11.5	12.0		9.0		12.0	9.0
2	10.5	6.0	9.5	8.0	3.5			
3	7.5	9.0	10.5	9.0	9.0			
4	9.0	5.5	12.5	13.5	7.5			
5	12.0	8.5	14.5	14.5				
6	13.0	14.5	15.0	13.0	7.0		10.0	13.5
7	12.0	9.5	9.5	13.0	12.0	5.5	9.5	11.0
8	11.0	11.5	11.5	11.5	10.0	5.5	11.5	
9	11.0	11.5	12.0	12.0	7.5	10.0	9.0	11.0
10	8.0	8.0	7.5	7.0	6.0			
11	5.5	6.5	7.5	7.0	5.5			
12	7.0	9.0	11.0	12.0	6.5			
13	11.5	13.0	13.0	12.5	6.5	6.0	9.5	8.5
14	7.5	9.0		12.0	7.0	8.0		10.5
15	10.0	12.0	14.5		7.0	10.5	8.5	11.0
16	9.0	12.5	11.0	13.5	8.0	7.0	13.0	10.0
17	7.5	12.0	14.5	14.0	9.5	10.0	12.5	12.0
18	11.0	11.5	6.0	7.0	8.5	6.5	9.0	8.0
19	10.0	12.0	11.0	10.5	6.0	6.5	7.5	9.5
20	10.0	9.0	10.0	10.0	9.5	7.0	9.0	9.0
21	9.5	9.0	10.0	10.5	8.5	9.0	9.0	9.0
22	8.0	8.5	11.5	12.0	6.0	8.0	8.0	10.0
23	10.5	11.0	11.5	11.5	6.5	9.0	6.0	10.0
24	10.0	10.5	12.5	11.5	6.5	8.5		10.5
25	9.5	10.0	10.5	10.5	7.5	9.0	9.5	5.0
26	8.5	6.5	8.0	10.0	5.0	6.5	7.0	9.5
27	9.5	10.0	10.5	11.0	7.0	7.5	8.5	6.5
28	10.0	9.0	11.5	10.5	6.5	8.5		9.5
29	9.5	9.5	10.5	11.0	8.5	8.5	9.0	8.5
30	10.0	8.5	10.0	10.0	8.5		9.0	7.5
31	9.5	9.0	9.5	9.5	8.0	8.5	8.5	7.5
1 August	9.5	10.0	11.0	10.0	7.0	10.0	9.5	10.0
2	9.5	11.5	12.5	12.5	8.5	11.5	11.5	
3	12.0	11.0	11.5	11.5	11.0	10.5	11.0	9.5
4	10.0	10.0	12.5	12.5	8.0	8.0	12.5	9.5
5	12.0	13.0	12.5	9.0	6.0	7.5	7.5	5.5
6	11.5	8.0	8.0	12.0	6.5	10.0	8.5	8.0
7	11.5	9.5	13.0	13.0	8.5	10.5	11.5	11.5
8	12.0	12.5	12.5	13.0	9.0	10.5	11.0	10.0
9	11.5	11.5	13.0	13.0	10.0	10.5	9.0	10.5
10	11.5	12.0	12.5	12.5	10.0	11.5	11.0	11.0
11	10.5	11.5	12.5	12.5	9.5	10.5	12.5	11.0
12	11.0	12.0	13.0	13.0	9.0	10.0	11.0	12.0
13	9.5	10.0	9.5	10.0	10.5	10.0	9.5	9.5
14	8.5	9.5	11.0	10.0	8.5	9.5	11.0	9.0
15	10.0	10.0	11.0	11.0	9.0	9.5	10.0	10.0
16	9.0	10.0	11.5	10.5	9.0	9.5	10.0	
17	8.0	9.0	9.5	7.5	9.5	9.0	9.0	7.5
18	8.0	8.0	8.5	8.5	6.5	8.0	8.5	8.5
19	7.0	7.0	7.0	7.5	7.5	7.0	7.0	6.5
20	5.5	7.0	8.0	7.0	6.0	7.0	8.0	7.5
21	7.0	7.0		6.0	7.0	6.5		
22	5.0				5.0			
23			4.0	4.0	4.0		4.0	
24	3.5	4.0	4.0	4.5	3.0		4.0	4.0
25	4.0	4.5	4.5	4.0	4.0	4.5	4.5	4.0
26	3.0	3.0	4.0	3.5	3.0	3.0	6.5	4.5
27	3.0	3.0	3.0	4.5	3.0	3.0	4.5	4.0
28	3.5	4.5	4.5	4.5	4.0	4.0	4.5	4.0
29	2.5	3.5	4.0	4.5	2.5	3.5	3.0	4.5
30	3.5	4.5	5.0	5.5	3.5	5.5	6.0	5.5
31	6.0	6.0	7.0	7.0	5.0	4.5	7.0	6.5
1 September	7.0	7.5	8.0	8.0	3.5	5.0	8.0	5.0
2	7.5	7.0	9.5	9.0	6.0	6.5	8.0	6.0
3	6.5	8.5	8.0	8.0	4.5	6.5	8.0	6.0
4	5.5	7.5	7.0	8.0	5.5	6.0	5.5	6.5
5	7.0	9.0	10.5	10.5	5.5	6.0	7.5	8.0
6	7.0	9.0	10.0	9.5	6.5	7.5	11.5	6.5
7	6.5	5.0	9.0	8.5	3.5	5.5	8.0	7.5
8	6.0				4.0			

Appendix A3. Water temperature, salinity, and catch data for gillnetting stations in Phillips Bay, 1986.

Date	Site	Species Captured							Total	Set Duration (min)	Water Temp. (°C)	Salinity (0/00)
		ARCS	LSCS	CHAR	ARFL	FHSC	RNSM	SFCD				
30 June	PB012											
	Surface	25	1	1					27	120	9.5	0.5
	Bottom					1			1	120	2.0	10.8
4 July	PB013											
	Surface	1							1	120	6.0	7.5
	Bottom								0	120	1.3	19.4
11 July	PB014											
	Surface								0	120	3.6	9.0
	Bottom								0	120	3.8	12.1
16 July	PB012											
	Surface	4							4	135	8.0	13.0
	Bottom				1				1	140	8.0	13.1
19 July	PB014											
	Surface								0	120	7.0	17.0
	Bottom								0	125	3.5	20.5
21 July	PB013											
	Surface								0	130	6.5	20.4
	Bottom				1				1	155	3.5	20.7
23 July	PB012											
	Surface	3							3	120	4.0	21.0
	Bottom								0	120	3.0	22.7
	PB014											
	Surface								0	120	5.0	19.3
	Bottom								0	120	3.0	22.2
28 July	PB013											
	Surface								0	120	8.0	19.3
	Bottom	3							3	135	9.0	18.2
29 July	PB012											
	Surface	1							1	120	8.5	14.0
	Bottom								0	120	6.5	19.1
31 July	PB014											
	Surface								0	110	6.0	17.5
	Bottom	1							1	110	5.5	17.2
4 August	PB012											
	Surface	7							7	120	7.5	17.5
	Bottom	1						1	2	120	3.5	24.0
7 August	PB013											
	Surface	21							21	120	9.0	17.0
	Bottom	19						1	20	120	8.5	17.3
	PB014											
	Surface	14							14	120	9.0	17.4
	Bottom	6	1						7	120	8.0	18.0
12 August	PB013											
	Surface	3							3	150	9.5	17.0
	Bottom	9							9	145	6.0	20.0

Appendix A3. Continued.

Date	Site	Species Captured							Total	Set Duration (min)	Water Temp. (°C)	Salinity (0/00)
		ARCS	LSCS	CHAR	ARFL	FHSC	RNSM	SFCD				
12 August	PB014											
	Surface	3							3	145	9.0	18.0
	Bottom	17							17	140	5.0	21.3
14 August	PB012											
	Surface								0	130	10.5	4.4
	Bottom	1				1	1	3	6	135	8.5	17.3
18 August	PB013											
	Surface								0	120	8.0	18.9
	Bottom					1			1	120	7.0	19.6
	PB014											
	Surface								0	120	7.5	19.0
	Bottom								0	120	5.5	21.1
20 August	PB012											
	Surface								0	120	6.0	20.0
	Bottom								0	120	5.5	20.3
29 August	PB013											
	Surface								0	60	4.0	17.5
	Bottom							1	1	65	2.0	21.8
30 August	PB012											
	Surface	5							5	180	3.0	20.1
	Bottom								0	180	1.0	22.9
	PB014											
	Surface								0	120	3.5	23.8
	Bottom								0	120	2.0	28.2
	TOTAL											
	Surface	87	1	1					89	2840		
	Bottom	57	1		4	2	5	1	70	2890		

Appendix A4.1. Numbers (N), percentage (%), and catch-per-unit-effort (CPUE) for fish captured in seines at each sampling location, Phillips Bay, 22-28 June 1986.

Site		Species Captured								Total	Shoreline Seined (m)	Water Temp. (°C)	Salinity (‰)
		ARCS	LSCS	CHAR	ARFL	FHSC	RNSM	ARGR	NSSB				
PB001	N				1		6			7	34	8.0	0.0
	%				14.3		85.7						
	CPUE				2.9		17.6						
PB002	N	2	3		15		41		1	62	106	11.0	0.0
	%	3.2	4.8		24.2		66.1		1.6				
	CPUE	1.9	2.8		14.2		38.7		0.9				
PB006	N		1	1	7		2			11	65	9.5	0.1
	%		9.1	9.1	63.6		18.2						
	CPUE		1.5	1.5	10.8		3.1						
PB066	N			1		6				7	55	9.5	0.1
	%			14.3		85.7							
	CPUE			1.8		10.9							
PB007	N									0	39	3.0	0.5
	%												
	CPUE												
PB008	N				4					4	43	7.5	0.8
	%				100.0								
	CPUE				9.3								
Total	N	2	4	2	27	6	49		1	91	342		
	%	2.2	4.4	2.2	29.7	6.6	53.8		1.1				
	CPUE	0.6	1.2	0.6	7.9	1.8	14.3		0.3				

Appendix A4.2. Numbers (N), percentage (%), and catch-per-unit-effort (CPUE) for fish captured in seines at each sampling location, Phillips Bay, 29 June - 5 July 1986.

Site		Species Captured								Total	Shoreline Seined (m)	Water Temp. (°C)	Salinity (‰)
		ARCS	LSCS	CHAR	ARFL	FHSC	RNSM	ARGR	NSSB				
PB001	N				4	2				6	38	14.0	1.4
	%				66.7	33.3							
	CPUE				10.5	5.3							
PB002	N									0	28	9.0	4.7
	%												
	CPUE												
PB006	N	1				5	1			7	62	7.0	5.9
	%	14.3				71.4	14.3						
	CPUE	1.6				8.1	1.6						
PB066	N				1	1				2	67	8.0	5.8
	%				50.0	50.0							
	CPUE				1.5	1.5							
PB007	N				6	11	7			24	75	12.0	0.0
	%				25.0	45.8	29.2						
	CPUE				8.0	14.7	9.3						
PB008	N				14	15				29	93	12.0	0.7
	%				48.3	51.7							
	CPUE				15.1	16.1							
Total	N	1			25	34	8			68	363		
	%	1.5			36.8	50.0	11.8						
	CPUE	0.3			6.9	9.4	2.2						

Appendix A4.3. Numbers (N), percentage (%), and catch-per-unit-effort (CPUE) for fish captured in seines at each sampling location, Phillips Bay, 6-12 July 1986.

Site		Species Captured								Total	Shoreline Seined (m)	Water Temp. (°C)	Salinity (‰)
		ARCS	LSCS	CHAR	ARFL	FHSC	RNSM	ARGR	NSSB				
PB001	N	1				6				7	54	7.0	2.3
	%	14.3				85.7							
	CPUE	1.9				11.1							
PB002	N	1		1	2	14	1			19	56	7.0	4.1
	%	5.3		5.3	10.5	73.7	5.3						
	CPUE	1.8		1.8	3.6	25.0	1.8						
PB006	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	%												
	CPUE												
PB066	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	%												
	CPUE												
PB007	N					5				5	43	5.0	4.3
	%					100.6							
	CPUE					11.6							
PB008	N					2				2	23	10.0	4.0
	%					100.0							
	CPUE					8.7							
Total	N	2		1	2	27	1			33	176		
	%	6.1		3.0	6.1	81.8	3.0						
	CPUE	1.1		0.6	1.1	15.3	0.6						

Appendix A4.4. Numbers (N), percentage (%), and catch-per-unit-effort (CPUE) for fish captured in seines at each sampling location, Phillips Bay, 13-19 July 1986.

Site		Species Captured								Total	Shoreline Seined (m)	Water Temp. (°C)	Salinity (‰)
		ARCS	LSCS	CHAR	ARFL	FHSC	RNSM	ARGR	NSSB				
PB001	N					1				1	61	14.0	5.1
	%					100.0							
	CPUE					1.6							
PB002	N				6	5	1			12	38	14.0	6.1
	%				50.0	41.7	8.3						
	CPUE				15.8	13.2	2.6						
PB006	N				1	1				2	79	11.0	10.9
	%				50.0	50.0							
	CPUE				1.3	1.3							
PB066	N				2	9				11	54	11.0	11.8
	%				18.2	81.8							
	CPUE				3.7	16.7							
PB007	N	1			2	9		1		13	50	8.0	14.9
	%	7.7			15.4	69.2		7.7					
	CPUE	2.0			4.0	18.0		2.0					
PB008	N	6			7	30				43	48	14.5	9.7
	%	14.0			16.3	69.8							
	CPUE	12.5			14.6	62.5							
Total	N	7			18	55	1	1		82	330		
	%	8.5			22.0	67.1	1.2	1.2					
	CPUE	2.1			5.5	16.7	0.3	0.3					

Appendix A4.5. Numbers (N), percentage (%), and catch-per-unit-effort (CPUE) for fish captured in seines at each sampling location, Phillips Bay, 20-26 July 1986.

Site		Species Captured								Total	Shoreline Seined (m)	Water Temp. (°C)	Salinity (‰)
		ARCS	LSCS	CHAR	ARFL	FHSC	RNSM	ARGR	NSSB				
PB001	N	23				7				30	50	11.0	6.5
	%	76.7				23.3							
	CPUE	46.0				14.0							
PB002	N	44				8				52	57	9.0	21.0
	%	84.6				15.4							
	CPUE	77.2				14.0							
PB006	N	2			3	104				109	53	9.0	16.9
	%	1.8			2.8	95.4							
	CPUE	3.8			5.7	196.2							
PB066	N					54				54	43	9.5	16.4
	%					100.0							
	CPUE					125.6							
PB007	N					6				6	50	5.0	23.0
	%					100.0							
	CPUE					12.0							
PB008	N	2				10				12	54	9.0	23.0
	%	16.7				83.3							
	CPUE	3.7				18.5							
Total	N	71			3	189				263	307		
	%	27.0			1.1	71.9							
	CPUE	23.1			1.0	61.6							

Appendix A4.6. Numbers (N), percentage (%), and catch-per-unit-effort (CPUE) for fish captured in seines at each sampling location, Phillips Bay, 27 July - 2 August 1986.

Site		Species Captured								Total	Shoreline Seined (m)	Water Temp. (°C)	Salinity (‰)
		ARCS	LSCS	CHAR	ARFL	FHSC	RNSM	ARGR	NSSB				
PB001	N	13			1	45				59	28	12.0	0.5
	%	22.0			1.7	76.3							
	CPUE	46.4			3.6	160.7							
PB002	N	278	1			3	10			292	30	12.0	9.0
	%	95.2	0.3			1.0	3.4						
	CPUE	926.7	3.3			10.0	33.3						
PB006	N		2		1	7				10	56	11.5	11.8
	%		20.7		10.0	70.0							
	CPUE		3.6		1.8	12.5							
PB066	N	225				178	1			404	103	12.0	8.7
	%	55.7				44.1	0.3						
	CPUE	218.4				172.8	1.0						
PB007	N					34				34	58	8.0	14.0
	%					100.0							
	CPUE					58.6							
PB008	N	3				108				111	58	11.0	6.3
	%	2.7				97.3							
	CPUE	5.2				186.2							
Total	N	519	3		2	375	11			910	333		
	%	57.0	0.3		0.2	41.2	1.2						
	CPUE	155.9	0.9		0.6	112.6	3.3						

Appendix A4.7. Numbers (N), percentage (%), and catch-per-unit-effort (CPUE) for fish captured in seines at each sampling location, Phillips Bay, 3-9 August 1986.

Site		Species Captured								Total	Shoreline Seined (m)	Water Temp. (°C)	Salinity (‰)
		ARCS	LSCS	CHAR	ARFL	FHSC	RNSM	ARGR	NSSB				
PB001	N	81					1			82	12	13.0	4.3
	%	98.8					1.2						
	CPUE	675.0					8.3						
PB002	N	5			1	35	24			65	89	13.0	6.1
	%	7.7			1.5	53.8	36.9						
	CPUE	5.6			1.1	39.3	27.0						
PB006	N		1			7	1			9	59	10.5	15.7
	%		11.1			77.8	11.1						
	CPUE		1.7			11.9	1.7						
PB066	N					43				43	73	10.0	15.7
	%					100.0							
	CPUE					58.9							
PB007	N					8				8	60	5.0	20.5
	%					100.0							
	CPUE					13.3							
PB008	N	96	1		13	95				205	57	13.0	4.0
	%	46.8	0.5		6.3	46.3							
	CPUE	168.4	1.8		22.8	166.7							
Total	N	182	2		14	188	26			412	350		
	%	44.2	0.5		3.4	45.6	6.3						
	CPUE	52.0	0.6		3.7	53.7	7.4						

Appendix A4.8. Numbers (N), percentage (%), and catch-per-unit-effort (CPUE) for fish captured in seines at each sampling location, Phillips Bay, 10-16 August 1986.

Site		Species Captured								Total	Shoreline Seined (m)	Water Temp. (°C)	Salinity (‰)
		ARCS	LSCS	CHAR	ARFL	FHSC	RNSM	ARGR	NSSB				
PB001	N	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
	%												
	CPUE												
PB002	N	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
	%												
	CPUE												
PB006	N	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
	%												
	CPUE												
PB066	N	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
	%												
	CPUE												
PB007	N				1	13				14	46	10.0	8.5
	%				7.1	92.9							
	CPUE				2.2	28.3							
PB008	N					15				15	59	11.0	6.5
	%					100.0							
	CPUE					25.4							
Total	N				1	28				29	105		
	%				3.4	26.6							
	CPUE				1.0	26.7							

Appendix A4.9. Numbers (N), percentage (%), and catch-per-unit-effort (CPUE) for fish captured in seines at each sampling location, Phillips Bay, 17-23 August 1986.

Site		Species Captured								Total	Shoreline Seined (m)	Water Temp. (°C)	Salinity (‰)
		ARCS	LSCS	CHAR	ARFL	FHSC	RNSM	ARGR	NSSB				
PB001	N	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
	%												
	CPUE												
PB002	N	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
	%												
	CPUE												
PB006	N									0	35	6.5	17.0
	%												
	CPUE												
PB066	N				2	9				11	66	5.5	10.8
	%				18.2	81.8							
	CPUE				3.0	13.6							
PB007	N	27	3			24			1	55	88	6.5	19.5
	%	49.1	5.5			43.6			1.8				
	CPUE	30.7	3.4			27.3			1.1				
PB008	N					1				1	67	7.0	11.3
	%					100.0							
	CPUE					1.5							
Total	N	27	3		2	34			1	67	256		
	%	40.3	4.5		3.0	50.7			1.5				
	CPUE	10.5	1.2		0.8	13.3			0.4				

Appendix A4.10. Numbers (N), percentage (%), and catch-per-unit-effort (CPUE) for fish captured in seines at each sampling location, Phillips Bay, 24-31 August 1986.

Site		Species Captured								Total	Shoreline Seined (m)	Water Temp. (°C)	Salinity (‰)
		ARCS	LSCS	CHAR	ARFL	FHSC	RNSM	ARGR	NSSB				
PB001	N					3	5		1	9	47	5.5	0.5
	%					33.3	55.6		11.1				
	CPUE					6.4	10.6		2.1				
PB002	N				2	15	10		2	29	33	4.0	5.7
	%				3.6	53.6	35.7		7.1				
	CPUE				3.0	45.5	30.3		6.1				
PB006	N					3				3	42	3.0	8.4
	%					100.0							
	CPUE					7.1							
PB066	N	7	1			84	3		1	96	29	6.0	19.0
	%	7.3	1.0			87.5	3.1		1.0				
	CPUE	24.1	3.4			289.7	10.3		3.4				
PB007	N	1				1				2	77	5.5	12.0
	%	50.0				50.0							
	CPUE	1.3				1.3							
PB008	N					35	1			36	49	4.5	9.0
	%					97.2	2.8						
	CPUE					71.4	2.0						
Total	N	8	1		2	141	19		4	175	277		
	%	4.6	0.6		1.1	80.6	10.9		2.3				
	CPUE	2.9	0.4		0.7	50.9	6.9		1.4				

Appendix A5.1. Daily catch of large (>250mm) Arctic cisco in each trap net, Phillips Bay, 1986.

Date	Single Trap	Double Trap		Total
		Eastward	Westward	
23 June	79	ND	ND	79
24	78	32	29	139
25	51	54	23	128
26	227	26	62	315
27	221	26	24	271
28	191	10	11	212
29	80	33	21	134
30	99	6		105
1 July	285	686	38	1 009
2	32	38	12	82
3	95	ND	ND	95
4	40	ND	ND	40
5	23	ND	ND	23
6	4	ND	ND	4
7	17	ND	ND	17
8	6	17	30	53
9	42	121	27	190
10	72	10	6	88
11	161	ND	ND	161
12	195	ND	ND	195
13	37	239	79	355
14	37	696	55	788
15	21	94	10	125
16	1	62	36	99
17		10	10	20
18	16	235	47	298
19	35	67	24	126
20	7	90	40	137
21	3	4	8	15
22	33	27	15	75
23	39	86	23	148
24	25	77	13	115
25	5	8	1	14
26	18	98	6	122
27	31	18	3	52
28	11	6	2	19
29	4	2	2	8
30	3	5	14	22
31	10			10
1 August	9	6		15
2	2	2	3	7
3	11	17	38	66
4	2	11	17	30
5	20	64	141	225
6	23	98	61	182
7		46	7	53
8	3	4	2	9
9	1	4	2	7
10		14	6	20
11		4		4
12	13	2	5	20
13	3	87	34	124
14	6	20	18	44
15		3	2	5
16	7	4	2	13
17	20	123	11	154
18	7	103	3	113
19	11	215	21	247
20	29	10	2	41
21	12	4	6	22
22	1	5	5	11
23	12	ND	ND	12
24	61	16	5	82
25	88	21	12	121
26	37	48	3	88
27	39	94	5	138
28	78	133	4	215
29	68	110	4	182
30	77	54	21	152
31	184	112	1	297
1 September	94	334	3	431
2	81	152	8	241
3	78	223	21	322
4	159	41	2	202
5	24	61	6	91
6	29	43	1	73
7	37	43	8	88
8	4	10	2	16
TOTAL	3 664	5 224	1 163	10 051

Appendix A5.2. Daily catch of small (<250mm) Arctic cisco in each trap net, Phillips Bay, 1986.

Date	Single Trap	Double Trap		Total
		Eastward	Westward	
23 June	3	ND	ND	3
24	4	3	1	8
25	14	4		18
26	15	2	1	18
27	6	2	1	9
28		3	7	10
29	7	3	4	14
30	79	1		80
1 July	26	2	6	34
2	7			7
3	28	ND	ND	28
4	21	ND	ND	21
5	5	ND	ND	5
6	2	ND	ND	2
7	9	ND	ND	9
8	10	13	2	25
9	29	23	3	55
10	3	5		8
11	26	ND	ND	26
12	32	ND	ND	32
13	22	41	2	65
14	21	35	3	59
15	29	105	2	136
16	17	25	1	43
17	20	45	3	68
18	15	45	11	71
19	47	13	1	61
20	94	36	6	136
21	388	156	14	558
22	423	46	4	473
23	56	46	4	106
24	514	55	20	589
25	344	244	4	592
26	33	12	9	54
27	366	781	19	1 166
28	484	15	7	506
29	223	7	1	231
30	202	5	1	208
31	207	10	11	228
1 August	177	19	3	199
2	729	26	4	759
3	60	37	9	106
4	42	124	65	231
5	27	164	98	289
6	20	734	78	832
7	5 825	601	19	6 445
8	945	222	15	1 182
9	1 615	78	31	1 724
10	353	420	26	799
11	1 077	169	7	1 253
12	102	314	9	425
13	75	42	8	125
14	1 491	425	7	1 923
15	541	3 387	10	3 938
16	245	490	24	759
17	909	1 040	150	2 099
18	650	365	431	1 446
19	321	203	31	555
20	329	307	11	647
21	284	7	10	301
22	3	17	15	35
23	16	ND	ND	16
24	766	51	12	829
25	545	64	13	622
26	114	74	11	199
27	313	47	50	410
28	44	82	31	157
29	72	84	72	228
30	36	132	90	258
31	44	138	4	186
1 September	212	304	51	567
2	153	623	42	818
3	504	159	23	686
4	139	180	2	321
5	471	2 899	5	3 375
6	392	223	2	617
7	125	1 374	43	1 542
8	11	261		272
TOTAL	23 608	17 669	1 660	42 937

Appendix A5.3. Daily catch of large (>250mm) least cisco in each trap net, Phillips Bay, 1986.

Date	Single Trap	Double Trap		Total
		Eastward	Westward	
23 June	24	ND	ND	24
24	33	75	39	147
25	40	147	64	251
26	34	68	74	176
27	55	55	38	148
28	55	28	28	111
29	38	163	27	228
30	56	38	28	122
1 July	102	221	138	461
2	52	113	39	204
3	318	ND	ND	318
4	106	ND	ND	106
5	112	ND	ND	112
6	18	ND	ND	18
7	105	ND	ND	105
8	128	180	295	603
9	202	101	121	424
10	86	42	68	196
11	44	ND	ND	44
12	119	ND	ND	119
13	35	216	82	333
14	26	171	122	319
15	69	193	61	323
16	12	208	193	413
17	8	32	74	114
18	18	153	79	250
19	125	128	57	310
20	50	238	66	354
21	19	23	32	74
22	84	125	44	253
23	106	199	34	339
24	62	366	36	464
25	13	63	8	84
26	23	111	11	145
27	193	62	69	324
28	142	16	18	176
29	85	11	10	106
30	78	10	13	101
31	96	10	6	112
1 August	41	19	26	86
2	35	16	4	55
3	44	64	174	282
4	59	37	7	103
5	18	125	32	175
6	6	33	23	62
7	7	25	53	85
8	13	25	35	73
9	16	26	23	65
10	7	15	13	35
11	12	20	11	43
12	20	18	14	52
13	7	18	22	47
14	6	26	4	36
15	7	12	23	42
16	8	36	11	55
17	8	19	25	52
18	13	8	4	25
19	4	10	9	23
20	14	11	13	38
21	28	14	9	51
22		5	2	7
23	2	ND	ND	2
24	10	3	2	15
25	17	3	1	21
26	6	9		15
27	7	6	1	14
28	4	7		11
29	24	4	1	29
30	8	10	1	19
31	7	20		27
1 September	32	10		42
2	16	10	1	27
3	7	11	3	21
4	8	10	2	20
5	4	8	1	13
6	1	4	1	6
7	1	8	2	11
8		2	1	3
TOTAL	3 498	4 273	2 528	10 299

Appendix A5.4. Daily catch of small (<250mm) least cisco in each trap net, Phillips Bay, 1986.

Date	Single Trap	Double Trap		Total
		Eastward	Westward	
23 June	1	ND	ND	1
24	1			1
25	9	5	1	15
26	9		5	14
27			1	1
28	9	1	5	15
29	6	3	2	11
30	40	8		48
1 July	21	8	15	44
2	4	4		8
3	9	ND	ND	9
4	10	ND	ND	10
5	7	ND	ND	7
6		ND	ND	0
7		ND	ND	0
8	9			9
9	47		4	51
10	8		2	11
11	7	ND	ND	7
12	12	ND	ND	12
13	23	4	3	30
14	59	12		71
15	14	40	4	58
16	3	28		31
17	8	23	15	46
18	49	35	11	95
19	68	31	12	111
20	82	101	12	195
21	404	123	19	546
22	228	48	6	282
23	52	49	13	114
24	394	98	8	500
25	212	65	10	287
26	63	29	7	99
27	115	128	12	255
28	158	17	10	185
29	83	53	10	146
30	71	8	5	84
31	76	23	2	101
1 August	93	36	6	135
2	77	43	3	123
3	31	38	18	87
4	15	109	29	153
5	23	143	101	267
6	15	143	37	195
7	670	86	32	788
8	95	92	39	226
9	764	92	43	899
10	87	40	32	159
11	90	12	6	108
12	45	81	15	141
13	79	18	3	100
14	126	28	8	162
15	122	363	4	489
16	116	370	17	503
17	104	105	60	269
18	48	21	10	79
19	35	19	3	57
20	235	61	14	310
21	166	18	26	210
22		7		7
23	1	ND	ND	1
24	51	6	6	63
25	31	20	16	67
26	22	28	11	61
27	50	9	15	74
28	31	72	13	116
29	74	19	22	115
30	20	29	1	50
31	24	19	3	46
1 September	32	12	10	54
2	33	18	3	54
3	30	15	4	49
4	27	20	3	50
5	64	112	8	184
6	57	16	6	79
7	62	65	9	136
8	3	2	2	7
TOTAL	6 019	3 332	832	10 183

Appendix A5.5. Daily catch of broad whitefish in each trap net, Phillips Bay, 1986.

Date	Single Trap	Double Trap		Total
		Eastward	Westward	
23 June		ND	ND	0
24	1			1
25	1		1	2
26		1		1
27			1	1
28		1		1
29		1	2	3
30				0
1 July	1	2	1	4
2				0
3		ND	ND	0
4		ND	ND	0
5	2	ND	ND	2
6		ND	ND	0
7	3	ND	ND	3
8	4	1	5	10
9	1	1	7	9
10	2		3	5
11	5	ND	ND	5
12	2	ND	ND	2
13	6	1	1	8
14		8	1	9
15	4	20	2	26
16	1	5	4	10
17	2	10	5	17
18	1	3	3	7
19	1	2	2	5
20		13	2	15
21	1	6	3	10
22	5	4	1	10
23	2	2		4
24	2	3		5
25	3	7		10
26	1	1		2
27	74	31	3	108
28	95	18	22	135
29	131	52		183
30	17	9	1	27
31	15	2	1	18
1 August	14	4		18
2	18	1		19
3	6	6	1	13
4	1	2	1	4
5		5	3	8
6	1	9		10
7	2			2
8	4	4	1	9
9	1			1
10	5	3		8
11	1	5		6
12	2	6		8
13		2		2
14		6	2	8
15	4	8	1	13
16	2	3		5
17	5	5		10
18	1			1
19	1	2	1	4
20	2	1		3
21				0
22				0
23				0
24	4			4
25	5	5	3	13
26		4		4
27	3	2		5
28	1	5	3	9
29	6	4	4	14
30	2	1		3
31		2		2
1 September	8	2	1	11
2	2	2		4
3		3		3
4	7	3	2	12
5	3	21	1	25
6	4	7	2	13
7		2		2
8		3		3
TOTAL	498	342	97	937

Appendix A5.6. Daily catch of lake whitefish in each trap net, Phillips Bay, 1986.

Date	Single Trap	Double Trap		Total
		Eastward	Westward	
23 June		ND	ND	0
24		1	2	3
25	1	2	1	4
26	1	2	3	6
27		5	2	7
28	2	4	1	7
29	3	1	3	7
30	1		1	2
1 July		1	1	2
2			1	1
3	2	ND	ND	2
4	2	ND	ND	2
5	4	ND	ND	4
6	2	ND	ND	2
7	5	ND	ND	5
8	16	5	5	26
9	22	13	31	66
10	10	4	12	26
11	8	ND	ND	8
12	24	ND	ND	24
13	10	7	5	22
14	4	5	8	17
15	4	2	7	13
16	2	4	18	24
17	8	1	25	34
18	1	2	5	8
19	2	1	3	6
20	5	2	1	8
21	1	1		2
22	2	3	1	6
23	1		1	2
24	3			3
25	1			1
26				0
27	1	1		2
28	1			1
29	2			2
30		1		1
31				0
1 August				0
2				0
3			1	1
4	1	1	1	3
5	1			1
6		1		1
7	1	2	1	4
8	1			1
9				0
10				0
11	1			1
12		1		1
13		3	3	6
14				0
15		2		2
16				0
17		2		2
18				0
19				0
20	2			2
21		1		1
22				0
23				0
24	1			1
25	1			1
26				0
27	1			1
28	1	1		2
29	2		1	3
30	1	3		4
31	2	2		4
1 September		4		4
2	1	1		2
3	1	4		5
4	5	1		6
5		2		2
6				
7				
8				
TOTAL	174	99	144	417

Appendix A5.7. Daily catch of Arctic charr in each trap net, Phillips Bay, 1986.

Date	Single Trap	Double Trap		Total
		Eastward	Westward	
23 June	31	ND	ND	31
24	29	19	10	58
25	45	26	16	87
26	42	9	10	61
27	45	7	5	57
28	54	6	5	65
29	38	21	3	62
30	65	2		67
1 July	35	11	6	52
2	13	2	2	17
3	65	ND	ND	65
4	50	ND	ND	50
5	14	ND	ND	14
6	15	ND	ND	15
7	19	ND	ND	19
8	7	1	1	9
9	11	5		16
10	4	2		6
11	9	ND	ND	9
12	7	ND	ND	7
13	2	4		6
14	3	2		5
15	2	1	2	5
16	8	2		10
17	6	1	2	9
18	1	2		3
19		4		4
20		2		2
21		6		6
22	1	3		4
23		4	1	5
24		1		1
25	1	1		2
26	2	2		4
27	1	5		6
28		8		8
29	2	8		10
30	2	5	1	8
31	3	8	1	12
1 August	2	17		19
2	2	6		8
3	1	23	4	28
4	1	37		38
5		8	1	9
6	1	2		3
7	1	4	2	7
8	4	9	2	15
9	2	8	2	12
10		3		3
11	2	2		4
12	1	3		4
13	2	1	1	4
14	1	4	5	10
15	3	3		6
16	20	6	1	27
17	3	8	2	13
18	5	7	5	17
19	11	13	12	36
20	37	6	8	51
21	7	2		9
22				
23	2	ND	ND	2
24	9	8	1	18
25	12	58	13	83
26	43	97	4	144
27	22	20	4	46
28	31	21	5	57
29	18	51	3	72
30	3	4		7
31	3	3	1	7
1 September	1	2		3
2	2	1	1	4
3	3	1		4
4	3	1		4
5	7	2	1	10
6	5	2		7
7	4	2		6
8	2			2
TOTAL	908	625	143	1 676

Appendix A5.8. Daily catch of rainbow smelt in each trap net, Phillips Bay, 1986.

Date	Single Trap	Double Trap		Total
		Eastward	Westward	
23 June	30	ND	ND	30
24	31	2	5	38
25	17	2	3	22
26	9	6	16	31
27	5	7	22	34
28	56	9	23	88
29	17	15	12	44
30	49	2	6	57
1 July	246	23	53	322
2	8	15		23
3	52	ND	ND	52
4	76	ND	ND	76
5	3	ND	ND	3
6	2	ND	ND	2
7		ND	ND	
8	10	3	6	19
9	73	17	83	173
10	39	6	22	67
11	86	ND	ND	86
12	73	ND	ND	73
13	18	10	4	32
14		2		2
15	29	25	39	93
16	6	52	41	99
17	34	69	26	129
18	42	30	8	80
19	8	74	47	129
20	29	53	20	102
21	39	8	70	117
22	52	56	71	189
23	25	379	82	486
24	68	32	52	152
25	34	31	20	85
26	7	70	11	88
27	16	163	19	198
28	22	218	22	262
29	112	101	94	307
30	14	312	27	353
31	30	130	7	167
1 August	21	92	6	119
2	4	154	8	166
3	8	44	68	120
4	26	65	24	115
5	12	138	15	165
6	8	69	13	90
7	6	14	55	75
8	10	25	79	114
9	14	38	44	96
10	11	33	23	67
11	5	58	4	67
12	26	39	15	80
13	3	44	5	52
14		9	3	12
15	2	8	3	13
16	12	55	33	100
17	9	57	36	102
18	3	43	9	55
19	6	14	3	23
20	1	34	18	53
21	17	48	36	101
22		8	2	10
23	12	ND	ND	12
24	3	3	6	12
25	7	18	8	33
26	25	180	21	226
27	13	131	37	181
28	36	11	22	69
29	118	41	20	179
30	38	148	16	202
31	7	203	20	230
1 September	25	40	37	102
2	25	68	16	109
3	24	37	12	73
4	149	47	12	208
5	24	47	3	74
6	25	9	2	36
7	12	10	10	32
8	9	7	8	24
TOTAL	2 223	4 021	1 663	7 907

Appendix A5.9. Daily catch of Arctic flounder in each trap net, Phillips Bay, 1986.

Date	Single Trap	Double Trap		Total
		Eastward	Westward	
23 June	458	ND	ND	458
24	350	142	143	635
25	103	96	200	399
26	63	392	456	911
27	148	352	452	952
28	283	108	356	747
29	172	715	33	920
30	85	287	65	437
1 July	497	1 567	343	2 407
2	124	1 256	62	1 442
3	300	ND	ND	300
4	693	ND	ND	693
5	316	ND	ND	316
6	575	ND	ND	575
7	320	ND	ND	320
8	197	1 078	84	1 359
9	237	635	129	1 001
10	121	296	173	590
11	169	ND	ND	169
12	510	ND	ND	510
13	415	1 103	132	1 650
14	109	345	168	622
15	429	149	276	854
16	185	834	374	1 393
17	335	1 997	205	2 537
18	1 309	1 121	284	2 714
19	47	710	843	1 600
20	74	252	289	615
21	139	295	514	948
22	245	268	275	788
23	340	240	566	1 146
24	373	126	332	831
25	262	249	149	660
26	84	582	103	769
27	75	165	80	320
28	114	134	25	273
29	56	85	42	183
30	59	142	41	242
31	113	242	71	426
1 August	48	77	48	173
2	35	130	39	204
3	36	132	119	287
4	271	803	33	1 107
5	305	394	32	731
6	176	208	50	434
7	73	77	134	284
8	230	80	180	490
9	135	120	79	334
10	68	100	41	209
11	87	74	118	279
12	205	38	105	348
13	63	119	122	304
14	90	160	56	306
15	118	340	102	560
16	107	345	328	780
17	94	256	104	454
18	26	119	110	255
19	23	120	204	347
20	78	102	175	355
21	66	406	191	663
22		115	21	136
23	6	ND	ND	6
24	13	10	43	66
25	19	36	18	73
26	103	117	20	240
27	41	110	98	249
28	34	24	32	90
29	132	42	51	225
30	73	51	35	159
31	12	18	8	38
1 September	183	41	38	262
2	68	71	39	178
3	36	86	43	165
4	49	55	20	124
5	19	29	10	58
6	20	80	11	111
7	24	87	18	129
8	11	33	5	49
TOTAL	13 661	21 168	10 145	44 974

Appendix A5.10. Daily catch of fourhorn sculpin in each trap net, Phillips Bay, 1986.

Date	Single Trap	Double Trap		Total
		Eastward	Westward	
23 June	11	ND	ND	11
24	22	3	5	30
25	55	17	15	87
26	16	16	13	45
27	8	14	13	35
28	48	13	33	94
29	50	81	21	152
30	61	7	6	74
1 July	160	65	93	318
2	63	81	12	156
3	55	ND	ND	55
4	54	ND	ND	54
5	33	ND	ND	33
6	50	ND	ND	50
7	87	ND	ND	87
8	87	18	7	112
9	57	41	39	137
10	87	20	26	133
11	78	ND	ND	78
12	61	ND	ND	61
13	46	20	24	90
14	52	77	50	179
15	91	20	30	141
16	93	81	54	228
17	52	34	54	140
18	74	705	268	1 047
19	51	683	674	1 408
20	27	45	163	235
21	37	22	57	116
22	55	27	43	125
23	53	29	80	162
24	36	10	29	75
25	79	32	21	132
26	83	233	141	457
27	38	41	77	156
28	80	40	29	149
29	34	12	38	84
30	36	21	26	83
31	38	14	22	74
1 August	24	14	17	55
2	49	11	13	73
3	75	26	71	172
4	51	17	26	94
5	58	12	10	80
6	52	41	41	134
7	77	22	41	140
8	144	24	49	217
9	96	24	29	149
10	53	24	13	90
11	59	17	46	122
12	61	20	38	119
13	29	32	79	140
14	13	19	14	46
15	28	7	33	68
16	57	14	45	116
17	38	117	65	220
18	14	32	30	76
19	14	21	25	60
20	48	10	11	69
21	63	16	14	93
22	1	37	13	51
23	10	ND	ND	10
24	24	3	6	33
25	14	1	5	20
26	93	5	3	101
27	30	28	18	76
28	30	10	22	62
29	89	9	21	119
30	72	24	37	133
31	17	4	12	33
1 September	45	12	24	81
2	24	60	26	110
3	49	58	56	163
4	49	15	10	74
5	30	21	7	58
6	45	31	9	85
7	16	46	5	67
8	15	19	4	38
TOTAL	3 954	3 425	3 151	10 530

Appendix A5.11. Daily catch of saffron cod in each trap net, Phillips Bay, 1986.

Date	Single Trap	Double Trap		Total
		Eastward	Westward	
23 June	2	ND	ND	2
24	3			3
25	2	1		3
26	1			1
27	1			1
28	1			1
29		1		1
30	1			1
1 July	3	2	4	9
2	12	8	3	23
3	14	ND	ND	14
4	88	ND	ND	88
5	203	ND	ND	203
6	43	ND	ND	43
7	111	ND	ND	111
8	86	1	8	95
9	52	23	31	106
10	11	8	4	23
11	3	ND	ND	3
12	15	ND	ND	15
13	36	13		49
14	34		5	39
15	17	1	9	27
16	10	3	20	33
17	2	2	13	17
18	6	17	4	27
19	6	79	54	139
20	7	1	6	14
21	1		2	3
22	1	2		3
23	3	18	3	24
24	6	1	3	10
25	5			5
26		42	4	46
27	2	2	1	5
28	1	3	1	5
29		8	2	10
30	6	10	17	33
31	3	17	4	24
1 August	8	7	4	19
2	2	4	3	9
3	12	1	13	26
4	5	2	16	23
5	3	2	1	6
6	20	6	15	41
7	1	3	36	40
8	13		26	39
9	7	9	4	20
10	6	3	11	20
11	2	2	10	14
12	2	3	3	8
13	6	9	80	95
14	1	1	38	40
15	1	1	21	23
16	1	1	20	22
17	10	20	37	67
18		3	13	16
19		4	11	15
20	2	5	10	17
21	10	38	38	86
22		2	1	3
23	1			1
24	2	2		4
25		9	3	12
26		7	3	10
27		16	12	28
28		1	28	29
29	2	4	17	23
30	3	6	16	25
31	7	18	20	45
1 September	7	12	7	26
2	9	16	9	34
3	2	16	12	30
4	4	22	25	51
5	9	23	11	43
6	27	42	28	97
7	16	19	28	63
8	12	6	26	44
TOTAL	1 011	608	854	2 473

Appendix A6.1. CPUE (no./h) recorded daily for large (>250mm) Arctic cisco in each trapnet.

Date	Single Trap	Double Trap			All Traps Combined
		Eastward	Westward	Combined	
23 June	5.75	ND	ND	ND	5.75
24	3.25	3.37	3.05	6.42	4.15
25	2.13	2.25	0.96	3.21	2.67
26	9.46	1.08	2.58	3.66	6.56
27	9.21	1.08	1.00	2.08	5.65
28	7.96	0.42	0.46	0.88	4.42
29	3.33	1.53	0.98	2.51	2.95
30	4.13	2.40	0.00	2.40	3.96
1 July	11.88	28.58	1.58	30.16	21.02
2	1.33	4.22	1.33	5.55	2.49
3	3.96	ND	ND	ND	3.96
4	1.67	ND	ND	ND	1.67
5	0.96	ND	ND	ND	0.96
6	0.17	ND	ND	ND	0.17
7	0.71	ND	ND	ND	0.71
8	0.25	1.48	2.61	4.09	1.49
9	1.75	5.04	1.13	6.17	3.96
10	3.00	1.11	0.67	1.78	2.67
11	6.71	ND	ND	ND	6.71
12	8.13	ND	ND	ND	8.13
13	1.54	10.99	3.63	14.62	7.76
14	0.71	29.00	2.29	31.29	16.42
15	0.88	3.92	0.42	4.34	2.60
16	0.04	2.58	1.50	4.08	2.06
17	0.00	0.42	0.42	0.84	0.42
18	0.67	9.79	1.96	11.75	6.21
19	1.46	2.79	1.00	3.79	2.63
20	0.29	3.75	1.67	5.42	2.85
21	0.13	0.17	0.33	0.50	0.31
22	1.38	1.13	0.63	1.76	1.56
23	1.63	3.58	0.96	4.54	3.08
24	1.04	3.21	0.54	3.75	2.40
25	0.21	0.33	0.04	0.37	0.29
26	0.75	4.08	0.25	4.33	2.54
27	1.29	0.75	0.13	0.88	1.08
28	0.46	0.25	0.08	0.33	0.40
29	0.17	0.08	0.08	0.16	0.17
30	0.13	0.33	0.80	1.13	0.53
31	0.42	0.00	0.00	0.00	0.21
1 August	0.38	0.25	0.00	0.25	0.31
2	0.08	0.11	0.16	0.27	0.16
3	0.46	0.71	1.58	2.29	1.38
4	0.08	0.46	0.71	1.17	0.63
5	0.83	2.67	5.88	8.55	4.69
6	0.96	4.08	2.54	6.62	3.79
7	0.00	1.92	0.29	2.21	1.10
8	0.13	0.17	0.08	0.25	0.19
9	0.04	0.17	0.08	0.25	0.15
10	0.00	0.58	0.25	0.83	0.42
11	0.00	0.17	0.00	0.17	0.08
12	0.54	0.08	0.21	0.29	0.42
13	0.13	3.63	1.42	5.05	2.58
14	0.25	0.83	0.75	1.58	0.92
15	0.00	0.13	0.08	0.21	0.10
16	0.29	0.17	0.13	0.30	0.27
17	0.83	5.13	0.46	5.59	3.21
18	0.29	4.29	0.13	4.42	2.35
19	0.46	8.96	0.88	9.84	5.15
20	1.21	0.42	0.08	0.50	0.85
21	0.50	0.29	0.43	0.72	0.58
22	0.11	0.26	0.26	0.52	0.39
23	1.14	ND	ND	ND	1.14
24	2.54	1.68	0.53	2.21	2.45
25	3.67	0.88	0.50	1.38	2.52
26	1.54	2.00	0.13	2.13	1.83
27	1.63	3.92	0.21	4.13	2.88
28	3.25	5.54	0.17	5.71	4.48
29	2.83	4.58	0.17	4.75	3.79
30	3.21	2.25	0.88	3.13	3.17
31	7.67	4.67	0.04	4.71	6.19
1 September	3.92	13.92	0.13	14.05	8.98
2	3.38	6.33	0.33	6.66	5.02
3	3.25	9.29	0.88	10.17	6.71
4	6.63	1.71	0.08	1.79	4.21
5	1.00	2.54	0.25	2.79	1.90
6	1.21	1.79	0.04	1.83	1.52
7	1.54	1.79	0.33	2.12	1.83
8	0.17	1.11	0.22	1.33	0.89

Appendix A6.2. CPUE (no./h) recorded daily for small (<250mm) Arctic cisco in each trapnet.

Date	Single Trap	Double Trap			All Traps Combined
		Eastward	Westward	Combined	
23 June	0.22	ND	ND	ND	0.22
24	0.17	0.32	0.11	0.43	0.24
25	0.58	0.17	0.00	0.17	0.38
26	0.63	0.08	0.04	0.12	0.38
27	0.25	0.08	0.04	0.12	0.19
28	0.00	0.13	0.29	0.42	0.21
29	0.29	0.14	0.19	0.33	0.31
30	3.29	0.40	0.00	0.40	3.02
1 July	1.08	0.08	0.25	0.33	0.71
2	0.29	0.00	0.00	0.00	0.21
3	1.17	ND	ND	ND	1.17
4	0.88	ND	ND	ND	0.88
5	0.21	ND	ND	ND	0.21
6	0.08	ND	ND	ND	0.08
7	0.38	ND	ND	ND	0.38
8	0.42	1.13	0.17	1.30	0.70
9	1.21	0.96	0.13	1.09	1.15
10	0.13	0.56	0.00	0.56	0.24
11	1.08	ND	ND	ND	1.08
12	1.33	ND	ND	ND	1.33
13	0.92	1.89	0.09	1.98	1.42
14	0.88	1.46	0.13	1.59	1.23
15	1.21	4.38	0.08	4.46	2.83
16	0.71	1.04	0.04	1.08	0.90
17	0.83	1.88	0.13	2.01	1.42
18	0.63	1.88	0.46	2.34	1.48
19	1.96	0.54	0.04	0.58	1.27
20	3.92	1.50	0.25	1.75	2.83
21	16.17	6.50	0.58	7.08	11.63
22	17.63	1.92	0.17	2.09	9.85
23	2.33	1.92	0.17	2.09	2.21
24	21.42	2.29	0.83	3.12	12.27
25	14.33	10.17	0.17	10.34	12.33
26	1.38	0.50	0.38	0.88	1.13
27	15.25	32.54	0.79	33.33	24.29
28	20.17	0.63	0.29	0.92	10.54
29	9.29	0.29	0.04	0.33	4.81
30	8.42	0.29	0.06	0.35	5.01
31	8.63	0.42	0.46	0.88	4.75
1 August	7.38	0.79	0.13	0.92	4.15
2	30.38	1.37	0.21	1.58	17.65
3	2.50	1.54	0.38	1.92	2.21
4	1.75	5.17	2.71	7.88	4.81
5	1.13	6.83	4.08	10.91	6.02
6	0.83	30.58	3.25	33.83	17.33
7	242.71	25.04	0.79	25.83	134.27
8	39.38	9.25	0.63	9.88	24.63
9	67.29	3.25	1.29	4.54	35.92
10	14.71	17.50	1.08	18.58	16.65
11	44.88	7.04	0.29	7.33	26.10
12	4.25	13.08	0.38	13.46	8.85
13	3.13	1.75	0.33	2.08	2.60
14	62.13	17.71	0.29	18.00	40.06
15	22.54	141.13	0.42	141.55	82.04
16	10.21	20.42	1.00	21.42	15.81
17	37.88	43.33	6.25	49.58	43.73
18	27.08	15.21	17.96	33.17	30.13
19	13.38	8.46	1.29	9.75	11.56
20	13.71	12.79	0.46	13.25	13.48
21	11.83	0.50	0.71	1.21	7.92
22	0.33	0.74	0.65	1.39	1.25
23	1.52	ND	ND	ND	1.52
24	31.92	5.37	1.26	6.63	24.75
25	22.71	2.67	0.54	3.21	12.96
26	4.75	3.08	0.46	3.54	4.15
27	13.04	1.96	2.08	4.04	8.54
28	1.83	3.42	1.29	4.71	3.27
29	3.00	3.50	3.00	6.50	4.75
30	1.50	5.50	3.75	9.25	5.38
31	1.83	5.75	0.17	5.92	3.88
1 September	8.83	12.67	2.13	14.80	11.81
2	6.38	25.96	1.75	27.71	17.04
3	21.00	6.63	0.96	7.59	14.29
4	5.79	7.50	0.08	7.58	6.69
5	19.63	120.79	0.21	121.00	70.31
6	16.33	9.29	0.08	9.37	12.85
7	5.21	57.25	1.79	59.04	32.13
8	0.46	29.00	0.00	29.00	15.11

Appendix A6.3. CPUE (no./h) recorded daily for large (>250mm) least cisco in each trapnet.

Date	Single Trap	Double Trap			All Traps Combined
		Eastward	Westward	Combined	
23 June	1.75	ND	ND	ND	1.75
24	1.38	7.90	4.11	12.01	4.39
25	1.67	6.13	2.67	8.80	5.23
26	1.42	2.83	3.08	5.91	3.67
27	2.29	2.29	1.58	3.87	3.08
28	2.29	1.17	1.17	2.34	2.31
29	1.58	7.58	1.26	8.84	5.01
30	2.33	15.20	11.20	26.40	4.60
1 July	4.25	9.21	5.75	14.96	9.60
2	2.17	12.56	4.33	16.89	6.18
3	13.25	ND	ND	ND	13.25
4	4.42	ND	ND	ND	4.42
5	4.67	ND	ND	ND	4.67
6	0.75	ND	ND	ND	0.75
7	4.38	ND	ND	ND	4.38
8	5.33	15.65	25.65	41.30	16.99
9	8.42	4.21	5.04	9.25	8.83
10	3.58	4.67	7.56	12.23	5.94
11	1.83	ND	ND	ND	1.83
12	4.96	ND	ND	ND	4.96
13	1.46	9.93	3.77	13.70	7.28
14	1.08	7.13	5.08	12.21	6.65
15	2.88	8.04	2.54	10.58	6.73
16	0.50	8.67	8.04	16.71	8.60
17	0.33	1.33	3.08	4.41	2.38
18	0.75	6.38	3.29	9.67	5.21
19	5.21	5.33	2.38	7.71	6.46
20	2.08	9.92	2.75	12.67	7.38
21	0.79	0.96	1.33	2.29	1.54
22	3.50	5.21	1.83	7.04	5.27
23	4.42	8.29	1.42	9.71	7.06
24	2.58	15.25	1.50	16.75	9.67
25	0.54	2.63	0.33	2.96	1.75
26	0.96	4.63	0.46	5.09	3.02
27	8.04	2.58	2.88	5.46	6.75
28	5.92	0.67	0.75	1.42	3.67
29	3.54	0.46	0.42	0.88	2.21
30	3.25	0.57	0.74	1.31	2.43
31	4.00	0.42	0.25	0.67	2.33
1 August	1.71	0.79	1.08	1.87	1.79
2	1.46	0.84	0.21	1.05	1.28
3	1.83	2.67	7.25	9.92	5.88
4	2.46	1.54	0.29	1.83	2.15
5	0.75	5.21	1.33	6.54	3.65
6	0.25	1.38	0.96	2.34	1.29
7	0.29	1.04	2.21	3.25	1.77
8	0.54	1.04	1.46	2.50	1.52
9	0.67	1.08	0.96	2.04	1.35
10	0.29	0.63	0.54	1.17	0.73
11	0.50	0.83	0.46	1.29	0.90
12	0.83	0.75	0.58	1.33	1.08
13	0.29	0.75	0.92	1.67	0.98
14	0.25	1.08	0.17	1.25	0.75
15	0.29	0.50	0.96	1.46	0.88
16	0.33	1.50	0.46	1.96	1.15
17	0.33	0.79	1.04	1.83	1.08
18	0.54	0.33	0.17	0.50	0.52
19	0.17	0.42	0.38	0.80	0.48
20	0.58	0.46	0.54	1.00	0.79
21	1.17	1.00	0.64	1.64	1.34
22	0.00	0.26	0.11	0.37	0.25
23	0.19	ND	ND	ND	0.19
24	0.42	0.32	0.21	0.53	0.45
25	0.71	0.13	0.04	0.17	0.44
26	0.25	0.38	0.00	0.38	0.31
27	0.29	0.25	0.04	0.29	0.29
28	0.17	0.29	0.00	0.29	0.23
29	1.00	0.17	0.04	0.21	0.60
30	0.33	0.42	0.04	0.46	0.40
31	0.29	0.83	0.00	0.83	0.56
1 September	1.33	0.42	0.00	0.42	0.88
2	0.67	0.42	0.04	0.46	0.56
3	0.29	0.46	0.13	0.59	0.44
4	0.33	0.42	0.08	0.50	0.42
5	0.17	0.33	0.04	0.37	0.27
6	0.04	0.17	0.04	0.21	0.13
7	0.04	0.33	0.08	0.41	0.23
8	0.00	0.22	0.11	0.33	0.17

Appendix A6.4. CPUE (no./h) recorded daily for small (<250mm) least cisco in each trapnet.

Date	Single Trap	Double Trap			All Traps Combined
		Eastward	Westward	Combined	
23 June	0.07	ND	ND	ND	0.07
24	0.04	0.00	0.00	0.00	0.03
25	0.38	0.21	0.04	0.25	0.31
26	0.38	0.00	0.21	0.21	0.29
27	0.00	0.00	0.04	0.04	0.02
28	0.38	0.04	0.21	0.25	0.31
29	0.25	0.14	0.09	0.23	0.24
30	1.67	3.20	0.00	3.20	1.81
1 July	0.88	0.33	0.63	0.96	0.92
2	0.17	0.44	0.00	0.44	0.24
3	0.38	ND	ND	ND	0.38
4	0.42	ND	ND	ND	0.42
5	0.29	ND	ND	ND	0.29
6	0.00	ND	ND	ND	0.00
7	0.00	ND	ND	ND	0.00
8	0.38	0.00	0.00	0.00	0.25
9	1.96	0.00	0.17	0.17	1.06
10	0.33	0.11	0.22	0.33	0.33
11	0.29	ND	ND	ND	0.29
12	0.50	ND	ND	ND	0.50
13	0.96	0.18	0.14	0.32	0.66
14	2.46	0.50	0.00	0.50	1.48
15	0.58	1.67	0.17	1.84	1.21
16	0.13	1.17	0.00	1.17	0.65
17	0.33	0.96	0.63	1.59	0.96
18	2.04	1.46	0.46	1.92	1.98
19	2.83	1.29	0.50	1.79	2.31
20	3.42	4.21	0.50	4.71	4.06
21	16.83	5.13	0.79	5.92	11.38
22	9.50	2.00	0.25	2.25	5.88
23	2.17	2.04	0.54	2.58	2.38
24	16.42	4.08	0.33	4.41	10.42
25	8.83	2.71	0.42	3.13	5.98
26	2.63	1.21	0.29	1.50	2.06
27	4.79	5.33	0.50	5.83	5.31
28	6.58	0.71	0.42	1.13	3.85
29	3.46	2.21	0.42	2.63	3.04
30	2.96	0.46	0.29	0.75	2.02
31	3.17	0.96	0.08	1.04	2.10
1 August	3.88	1.50	0.25	1.75	2.81
2	3.21	2.26	0.16	2.42	2.86
3	1.29	1.58	0.75	2.33	1.81
4	0.63	4.54	1.21	5.75	3.19
5	0.96	5.96	4.21	10.17	5.56
6	0.63	5.96	1.54	7.50	4.06
7	27.92	3.58	1.33	4.91	16.42
8	3.96	3.83	1.63	5.46	4.71
9	31.83	3.83	1.79	5.62	18.73
10	3.63	1.67	1.33	3.00	3.31
11	3.75	0.50	0.25	0.75	2.25
12	1.88	3.38	0.63	4.01	2.94
13	3.29	0.75	0.13	0.88	2.08
14	5.25	1.17	0.33	1.50	3.38
15	5.08	15.13	0.17	15.30	10.19
16	4.83	15.42	0.71	16.13	10.48
17	4.33	4.38	2.50	6.88	5.60
18	2.00	0.88	0.42	1.30	1.65
19	1.46	0.79	0.13	0.92	1.19
20	9.79	2.54	0.58	3.12	6.46
21	6.92	1.29	1.86	3.15	5.53
22	0.00	0.37	0.00	0.37	0.25
23	0.10	ND	ND	ND	0.10
24	2.13	0.63	0.63	1.26	1.88
25	1.29	0.83	0.67	1.50	1.40
26	0.92	1.17	0.46	1.63	1.27
27	2.08	0.38	0.63	1.01	1.54
28	1.29	3.00	0.54	3.54	2.42
29	3.08	0.79	0.92	1.71	2.40
30	0.83	1.21	0.04	1.25	1.04
31	1.00	0.79	0.13	0.92	0.96
1 September	1.33	0.50	0.42	0.92	1.13
2	1.38	0.75	0.13	0.88	1.13
3	1.25	0.63	0.17	0.80	1.02
4	1.13	0.83	0.13	0.96	1.04
5	2.67	4.67	0.33	5.00	3.83
6	2.38	0.67	0.25	0.92	1.65
7	2.58	2.71	0.38	3.09	2.83
8	0.33	0.22	0.22	0.44	0.39

Appendix A6.5. CPUE (no./h) recorded daily for Arctic charr in each trapnet.

Date	Single Trap	Double Trap			All Traps Combined
		Eastward	Westward	Combined	
23 June	2.26	ND	ND	ND	2.26
24	1.21	2.00	1.05	3.05	1.73
25	1.88	1.08	0.67	1.75	1.81
26	1.75	0.38	0.42	0.80	1.27
27	1.88	0.29	0.21	0.50	1.19
28	2.25	0.25	0.21	0.46	1.35
29	1.58	0.98	0.14	1.12	1.36
30	2.71	0.80	0.00	0.80	2.53
1 July	1.46	0.46	0.25	0.71	1.08
2	0.54	0.22	0.22	0.44	0.52
3	2.71	ND	ND	ND	2.71
4	2.08	ND	ND	ND	2.08
5	0.58	ND	ND	ND	0.58
6	0.63	ND	ND	ND	0.63
7	0.79	ND	ND	ND	0.79
8	0.29	0.09	0.09	0.18	0.25
9	0.46	0.21	0.00	0.21	0.33
10	0.17	0.22	0.00	0.22	0.18
11	0.38	ND	ND	ND	0.38
12	0.29	ND	ND	ND	0.29
13	0.08	0.18	0.00	0.18	0.13
14	0.13	0.08	0.00	0.08	0.10
15	0.08	0.04	0.08	0.12	0.10
16	0.33	0.08	0.00	0.08	0.21
17	0.25	0.04	0.08	0.12	0.19
18	0.04	0.08	0.00	0.08	0.06
19	0.00	0.17	0.00	0.17	0.08
20	0.00	0.08	0.00	0.08	0.04
21	0.00	0.25	0.00	0.25	0.13
22	0.04	0.13	0.00	0.13	0.08
23	0.00	0.17	0.04	0.21	0.10
24	0.00	0.04	0.00	0.04	0.02
25	0.04	0.04	0.00	0.04	0.04
26	0.08	0.08	0.00	0.08	0.08
27	0.04	0.21	0.00	0.21	0.13
28	0.00	0.33	0.00	0.33	0.17
29	0.08	0.33	0.00	0.33	0.21
30	0.08	0.29	0.06	0.35	0.19
31	0.13	0.33	0.04	0.37	0.25
1 August	0.08	0.71	0.00	0.71	0.40
2	0.08	0.32	0.00	0.32	0.19
3	0.04	0.96	0.17	1.13	0.58
4	0.04	1.54	0.00	1.54	0.79
5	0.00	0.33	0.04	0.37	0.19
6	0.04	0.08	0.00	0.08	0.06
7	0.04	0.17	0.08	0.25	0.15
8	0.17	0.38	0.08	0.46	0.31
9	0.08	0.33	0.08	0.41	0.25
10	0.00	0.13	0.00	0.13	0.06
11	0.08	0.08	0.00	0.08	0.08
12	0.04	0.13	0.00	0.13	0.08
13	0.08	0.04	0.04	0.08	0.08
14	0.04	0.17	0.21	0.38	0.21
15	0.13	0.13	0.00	0.13	0.13
16	0.83	0.25	0.04	0.29	0.56
17	0.13	0.33	0.08	0.41	0.27
18	0.21	0.29	0.21	0.50	0.35
19	0.46	0.54	0.50	1.04	0.75
20	1.54	0.25	0.33	0.58	1.06
21	0.29	0.14	0.00	0.14	0.24
22	0.00	0.00	0.00	0.00	0.00
23	0.19	ND	ND	ND	0.19
24	0.38	0.84	0.11	0.95	0.54
25	0.50	2.42	0.54	2.96	1.73
26	1.79	4.04	0.17	4.21	3.00
27	0.92	0.83	0.17	1.00	0.96
28	1.29	0.88	0.21	1.09	1.19
29	0.75	2.13	0.13	2.26	1.50
30	0.13	0.17	0.00	0.17	0.15
31	0.13	0.13	0.04	0.17	0.15
1 September	0.04	0.08	0.00	0.08	0.06
2	0.08	0.04	0.04	0.08	0.08
3	0.13	0.04	0.00	0.04	0.08
4	0.13	0.04	0.00	0.04	0.08
5	0.29	0.08	0.04	0.12	0.21
6	0.21	0.08	0.00	0.08	0.15
7	0.17	0.08	0.00	0.08	0.13
8	0.22	0.00	0.00	0.00	0.11

Appendix A6.6. CPUE (no./h) recorded daily for rainbow smelt in each trapnet.

Date	Single Trap	Double Trap			All Traps Combined
		Eastward	Westward	Combined	
23 June	2.18	ND	ND	ND	2.18
24	1.29	0.21	0.53	0.74	1.13
25	0.71	0.08	0.13	0.21	0.46
26	0.38	0.25	0.67	0.92	0.65
27	0.21	0.29	0.92	1.21	0.71
28	2.33	0.38	0.96	1.34	1.83
29	0.71	0.70	0.56	1.26	0.97
30	2.04	0.80	2.40	3.20	2.15
1 July	10.25	0.96	2.21	3.17	6.71
2	0.33	1.67	0.00	1.67	0.70
3	2.17	ND	ND	ND	2.17
4	3.17	ND	ND	ND	3.17
5	0.13	ND	ND	ND	0.13
6	0.08	ND	ND	ND	0.08
7	0.00	ND	ND	ND	0.00
8	0.42	0.26	0.52	0.78	0.54
9	3.04	0.71	3.46	4.17	3.60
10	1.63	0.67	2.44	3.11	2.03
11	3.58	ND	ND	ND	3.58
12	3.04	ND	ND	ND	3.04
13	0.75	0.46	0.18	0.64	0.70
14	0.00	0.08	0.00	0.08	0.04
15	1.21	1.04	1.63	2.67	1.94
16	0.25	2.17	1.71	3.88	2.06
17	1.42	2.88	1.08	3.96	2.69
18	1.75	1.25	0.33	1.58	1.67
19	0.33	3.08	1.96	5.04	2.69
20	1.21	2.21	0.83	3.04	2.13
21	1.63	0.33	2.92	3.25	2.44
22	2.17	2.75	2.96	5.71	3.94
23	1.04	15.79	3.42	19.21	10.13
24	2.83	1.33	2.17	3.50	3.17
25	1.42	1.29	0.83	2.12	1.77
26	0.29	2.92	0.46	3.38	1.83
27	0.67	6.79	0.79	7.58	4.13
28	0.92	9.08	0.92	10.00	5.46
29	4.67	4.21	3.92	8.13	6.40
30	0.58	17.83	1.54	19.37	8.51
31	1.25	5.42	0.29	5.71	3.48
1 August	0.88	3.83	0.25	4.08	2.48
2	0.17	8.11	0.42	8.53	3.86
3	0.33	1.83	2.83	4.66	2.50
4	1.08	2.71	1.00	3.71	2.40
5	0.50	5.75	0.63	6.38	3.44
6	0.33	2.88	0.54	3.42	1.88
7	0.25	0.58	2.29	2.87	1.56
8	0.42	1.04	3.29	4.33	2.38
9	0.58	1.58	1.83	3.41	2.00
10	0.46	1.38	0.96	2.34	1.40
11	0.21	2.42	0.17	2.59	1.40
12	1.08	1.63	0.63	2.26	1.67
13	0.13	1.83	0.21	2.04	1.08
14	0.00	0.38	0.13	0.51	0.25
15	0.08	0.33	0.13	0.46	0.27
16	0.50	2.29	1.38	3.67	2.08
17	0.38	2.38	1.50	3.88	2.13
18	0.13	1.79	0.38	2.17	1.15
19	0.25	0.58	0.13	0.71	0.48
20	0.04	1.42	0.75	2.17	1.10
21	0.71	3.43	2.57	6.00	2.66
22	0.00	0.42	0.11	0.53	0.36
23	1.14	ND	ND	ND	1.14
24	0.13	0.32	0.63	0.95	0.36
25	0.29	0.75	0.33	1.08	0.69
26	1.04	7.50	0.88	8.38	4.71
27	0.54	5.46	1.54	7.00	3.77
28	1.50	0.46	0.92	1.38	1.44
29	4.92	1.71	0.83	2.54	3.73
30	1.58	6.17	0.67	6.84	4.21
31	0.29	8.46	0.83	9.29	4.79
1 September	1.04	1.67	1.54	3.31	2.13
2	1.04	2.83	0.67	3.50	2.27
3	1.00	1.54	0.50	2.04	1.52
4	6.21	1.96	0.50	2.46	4.33
5	1.00	1.96	0.13	2.09	1.54
6	1.04	0.38	0.08	0.46	0.75
7	0.50	0.42	0.42	0.84	0.67
8	1.00	0.78	0.89	1.67	1.33

Appendix A6.7. CPUE (no./h) recorded daily for Arctic flounder in each trapnet.

Date	Single Trap	Double Trap			All Traps Combined
		Eastward	Westward	Combined	
23 June	33.31	ND	ND	ND	33.31
24	14.58	14.95	15.05	30.00	18.96
25	4.29	4.00	8.33	12.33	8.31
26	2.63	16.33	19.00	35.33	18.98
27	6.17	14.67	18.83	33.50	19.83
28	11.79	4.50	14.83	19.33	15.56
29	7.17	33.26	1.54	34.80	20.22
30	3.54	114.80	26.00	140.80	16.49
1 July	20.71	65.29	14.29	79.58	50.15
2	5.17	139.56	6.89	146.45	43.70
3	12.50	ND	ND	ND	12.50
4	28.87	ND	ND	ND	28.88
5	13.17	ND	ND	ND	13.17
6	23.96	ND	ND	ND	23.96
7	13.33	ND	ND	ND	13.33
8	8.21	93.74	7.30	101.04	38.28
9	9.88	26.46	5.38	31.84	20.85
10	5.04	32.89	19.22	52.11	17.88
11	7.04	ND	ND	ND	7.04
12	21.25	ND	ND	ND	8.75
13	17.29	50.71	6.07	56.78	36.07
14	4.54	14.38	7.00	21.38	12.96
15	17.88	6.20	11.50	17.70	17.79
16	7.71	34.75	15.58	50.33	29.02
17	13.96	83.21	8.54	91.75	52.85
18	54.54	46.67	11.83	58.50	50.54
19	1.96	29.58	35.13	64.71	33.33
20	3.08	10.50	12.04	22.54	12.81
21	5.79	12.29	21.42	33.71	19.75
22	10.21	11.17	11.46	22.63	16.42
23	14.17	10.00	23.58	33.58	23.88
24	15.54	5.25	13.83	19.08	17.31
25	10.92	10.38	6.21	16.59	13.75
26	3.50	24.25	4.29	28.54	16.02
27	3.13	6.88	3.33	10.21	6.67
28	4.75	5.58	1.04	6.62	5.69
29	2.33	3.54	1.75	5.29	3.81
30	2.46	8.11	2.34	10.45	5.83
31	4.71	10.08	2.96	13.04	8.88
1 August	2.00	3.21	2.00	5.21	3.60
2	1.46	6.84	2.05	8.89	4.74
3	1.50	5.50	4.96	10.46	5.98
4	11.29	33.46	1.38	34.84	23.06
5	12.71	16.42	1.33	17.75	15.23
6	7.33	8.67	2.08	10.75	9.04
7	3.04	3.21	5.58	8.79	5.92
8	9.58	3.33	7.50	10.83	10.21
9	5.63	5.00	3.29	8.29	6.96
10	2.83	4.17	1.71	5.88	4.35
11	3.63	3.08	4.92	8.00	5.81
12	8.54	1.58	4.38	5.96	7.25
13	2.63	4.96	5.08	10.04	6.33
14	3.75	6.67	2.33	9.00	6.38
15	4.92	14.17	4.25	18.42	11.67
16	4.46	14.38	13.67	28.05	16.25
17	3.92	10.67	4.33	15.00	9.46
18	1.08	4.96	4.58	9.54	5.31
19	0.96	5.00	8.50	13.50	7.23
20	3.25	4.25	7.29	11.54	7.40
21	2.75	29.00	13.64	42.64	17.45
22	0.00	6.05	1.11	7.16	4.86
23	0.57	ND	ND	ND	0.57
24	0.54	1.05	4.53	5.58	1.97
25	0.79	1.50	0.75	2.25	1.52
26	4.29	4.88	0.83	5.71	5.00
27	1.71	4.58	4.08	8.62	5.19
28	1.42	1.00	1.33	2.33	1.88
29	5.50	1.75	2.13	3.88	4.69
30	3.04	2.13	1.46	3.59	3.31
31	0.50	0.75	0.33	1.08	0.79
1 September	7.63	1.71	1.58	3.29	5.46
2	2.83	2.96	1.63	4.59	3.71
3	1.50	3.58	1.79	5.37	3.44
4	2.04	2.29	0.83	3.12	2.58
5	0.79	1.21	0.42	1.63	1.21
6	0.83	3.33	0.46	3.79	2.31
7	1.00	3.63	0.75	4.38	2.69
8	1.22	3.67	0.56	4.23	2.72

Appendix A6.8. CPUE (no./h) recorded daily for fourhorn sculpin in each trapnet.

Date	Single Trap	Double Trap			All Traps Combined
		Eastward	Westward	Combined	
23 June	0.80	ND	ND	ND	0.80
24	0.92	0.32	0.53	0.85	0.90
25	2.29	0.71	0.63	1.34	1.81
26	0.67	0.67	0.54	1.21	0.94
27	0.33	0.58	0.54	1.12	0.73
28	2.00	0.54	1.38	1.92	1.96
29	2.08	3.77	0.98	4.75	3.34
30	2.54	2.80	2.40	5.20	2.79
1 July	6.67	2.71	3.88	6.59	6.63
2	2.63	9.00	1.33	10.33	4.73
3	2.29	ND	ND	ND	2.29
4	2.25	ND	ND	ND	2.25
5	1.38	ND	ND	ND	1.38
6	2.08	ND	ND	ND	2.08
7	3.63	ND	ND	ND	3.63
8	3.63	1.57	0.61	2.18	3.16
9	2.38	1.71	1.63	3.34	2.85
10	3.63	2.22	2.89	5.11	4.03
11	3.25	ND	ND	ND	3.25
12	2.54	ND	ND	ND	2.54
13	1.92	0.92	1.10	2.02	1.97
14	2.17	3.21	2.08	5.29	3.73
15	3.79	0.83	1.25	2.08	2.94
16	3.88	3.38	2.25	5.63	4.75
17	2.17	1.42	2.25	3.67	2.92
18	3.08	29.38	1.17	30.55	21.81
19	2.13	28.46	28.08	56.54	29.33
20	1.13	1.88	6.79	8.67	4.90
21	1.54	0.92	2.38	3.30	2.42
22	2.29	1.13	1.79	2.92	2.60
23	2.21	1.21	3.33	4.54	3.38
24	1.50	0.42	1.21	1.63	1.56
25	3.29	1.33	0.88	2.21	2.75
26	3.46	9.71	5.88	15.59	9.52
27	1.58	1.71	3.21	4.92	3.25
28	3.33	1.67	1.21	2.88	3.10
29	1.42	0.50	1.58	2.08	1.75
30	1.50	1.20	1.49	2.69	2.00
31	1.58	0.58	0.92	1.50	1.54
1 August	1.00	0.58	0.71	1.29	1.15
2	2.04	0.58	0.68	1.26	1.70
3	3.13	1.08	2.96	4.04	3.58
4	2.13	0.71	1.08	1.79	1.96
5	2.42	0.50	0.42	0.92	1.67
6	2.17	1.71	1.71	3.42	2.79
7	3.21	0.92	1.71	2.63	2.92
8	6.00	1.00	2.04	3.04	4.52
9	4.00	1.00	1.21	2.21	3.10
10	2.21	1.00	0.54	1.54	1.88
11	2.46	0.71	1.92	2.63	2.54
12	2.54	0.83	1.58	2.41	2.48
13	1.21	1.33	3.29	4.62	2.92
14	0.54	0.79	0.58	1.37	0.96
15	1.17	0.29	1.38	1.67	1.42
16	2.38	0.58	1.88	2.46	2.42
17	1.58	4.88	2.71	7.59	4.58
18	0.58	1.33	1.25	2.58	1.58
19	0.58	0.88	1.04	1.92	1.25
20	2.00	0.42	0.46	0.88	1.44
21	2.63	1.14	1.00	2.14	2.45
22	0.11	1.95	0.68	2.63	1.82
23	0.95	ND	ND	ND	0.95
24	1.00	0.32	0.63	0.95	0.99
25	0.58	0.04	0.21	0.25	0.42
26	3.88	0.21	0.13	0.34	2.10
27	1.25	1.17	0.75	1.92	1.58
28	1.25	0.42	0.92	1.34	1.29
29	3.71	0.38	0.88	1.26	2.48
30	3.00	1.00	1.54	2.54	2.77
31	0.71	0.17	0.50	0.67	0.69
1 September	1.88	0.50	1.00	1.50	1.69
2	1.00	2.50	1.08	3.58	2.29
3	2.04	2.42	2.33	4.75	3.40
4	2.04	0.63	0.42	1.05	1.54
5	1.25	0.88	0.29	1.17	1.21
6	1.88	1.29	0.38	1.67	1.77
7	0.67	1.92	0.21	2.13	1.40
8	1.67	2.11	0.44	2.55	2.11

Appendix A6.9. CPUE (no./h) recorded daily for saffron cod in each trapnet.

Date	Single Trap	Double Trap			All Traps Combined
		Eastward	Westward	Combined	
23 June	0.15	ND	ND	ND	0.15
24	0.13	0.00	0.00	0.00	0.09
25	0.08	0.04	0.00	0.04	0.06
26	0.04	0.00	0.00	0.00	0.02
27	0.04	0.00	0.00	0.00	0.02
28	0.04	0.00	0.00	0.00	0.02
29	0.00	0.05	0.00	0.05	0.02
30	0.04	0.00	0.00	0.00	0.04
1 July	0.13	0.08	0.17	0.25	0.19
2	0.50	0.89	0.13	1.02	0.70
3	0.58	ND	ND	ND	0.58
4	3.67	ND	ND	ND	3.67
5	8.46	ND	ND	ND	8.46
6	1.79	ND	ND	ND	1.79
7	4.63	ND	ND	ND	4.63
8	3.58	0.09	0.70	0.79	2.68
9	2.17	0.96	1.29	2.25	2.21
10	0.46	0.89	0.44	1.33	0.70
11	0.13	ND	ND	ND	0.13
12	0.63	ND	ND	ND	0.63
13	1.50	0.60	0.00	0.60	1.07
14	1.42	0.00	0.21	0.21	0.81
15	0.71	0.04	0.38	0.42	0.56
16	0.42	0.13	0.83	0.96	0.69
17	0.08	0.08	0.54	0.64	0.35
18	0.25	0.71	0.17	0.88	0.56
19	0.25	3.29	2.25	5.54	2.90
20	0.29	0.04	0.25	0.29	0.29
21	0.04	0.00	0.08	0.08	0.06
22	0.04	0.08	0.00	0.08	0.06
23	0.13	0.75	0.13	0.88	0.50
24	0.25	0.04	0.13	0.17	0.21
25	0.21	0.00	0.00	0.00	0.10
26	0.00	1.75	0.17	1.92	0.96
27	0.08	0.08	0.04	0.12	0.10
28	0.04	0.13	0.04	0.17	0.10
29	0.00	0.33	0.08	0.41	0.21
30	0.25	0.57	0.97	1.54	0.80
31	0.13	0.71	0.17	0.88	0.50
1 August	0.33	0.29	0.17	0.46	0.40
2	0.08	0.21	0.16	0.37	0.21
3	0.50	0.04	0.54	0.58	0.54
4	0.21	0.08	0.67	0.75	0.48
5	0.13	0.08	0.04	0.12	0.13
6	0.83	0.25	0.63	0.88	0.85
7	0.04	0.13	1.50	1.83	0.83
8	0.54	0.00	1.08	1.08	0.81
9	0.29	0.38	0.17	0.55	0.42
10	0.25	0.13	0.46	0.59	0.42
11	0.08	0.08	0.42	0.50	0.29
12	0.08	0.13	0.13	0.26	0.17
13	0.25	0.38	3.33	3.71	1.98
14	0.04	0.04	1.58	1.62	0.83
15	0.04	0.04	0.88	0.92	0.48
16	0.04	0.04	0.83	0.87	0.46
17	0.42	0.83	1.54	2.37	1.40
18	0.00	0.13	0.54	0.67	0.33
19	0.00	0.17	0.46	0.63	0.31
20	0.08	0.21	0.42	0.43	0.35
21	0.42	2.71	2.71	5.42	2.26
22	0.00	0.11	0.05	0.16	0.11
23	0.10	ND	ND	ND	0.10
24	0.08	0.21	0.00	0.21	0.12
25	0.00	0.38	0.13	0.51	0.25
26	0.00	0.29	0.13	0.42	0.21
27	0.00	0.67	0.50	1.27	0.58
28	0.00	0.04	1.17	1.21	0.60
29	0.08	0.17	0.71	0.88	0.48
30	0.13	0.25	0.33	0.58	0.52
31	0.29	0.75	0.83	1.58	0.94
1 September	0.29	0.50	0.29	0.79	0.54
2	0.38	0.67	0.38	1.05	0.71
3	0.08	0.67	0.50	1.17	0.63
4	0.17	0.92	1.04	1.96	1.06
5	0.38	0.96	0.46	1.42	0.90
6	1.13	1.75	1.17	2.92	2.02
7	0.67	0.79	1.17	1.96	1.31
8	1.33	0.67	2.89	3.56	2.44

Appendix A7.1. Length-frequency distribution for measured samples of Arctic cisco captured in single trap by sampling period, Phillips Bay, 1986.

Fork Length (mm)	Number by Sampling Period												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
0- 9													
10-19													
20-29													
30-39				7						1			8
40-49				16	1	15	1	2	1				36
50-59				6	2	132	39	65	39	46	22	1	352
60-69				3	12	118	85	93	85	74	64	14	548
70-79			1	10	47	27	28	38	60	47	60	13	331
80-89	1		12	10	53	12	5	12	15	21	18	6	165
90-99		2	10	25	51	19	23	16	4	4	5		159
100-109		1	2	13	40	21	21	25	13	4	3		143
110-119		1		5	5	8	8	16	17	14	9	8	91
120-129	2	1		6	10	5	1	8	7	7	7	6	60
130-139	1	1	2	2	7	1	3	4	7	5	5	3	41
140-149	1	4	2	2	4	1	11	11	5		5		46
150-159	1		1	4	9	4	5	5	5	6	3	2	45
160-169	1	3	4	6	3	1	3	10	4	5	2	2	44
170-179	4	6	3	4	13	3	1	9	9	3	5	2	62
180-189	1	4	6	1	11	3	1	12	7	3	1	1	51
190-199	1	3	5	7	5	3	2	7	6	4	1		44
200-209		1	3	3	4	5	3	6	4	9	2		40
210-219		11	7	1	3	2	2	7	3	4	1	1	42
220-229	2	9	9	9	2	4	3	6	7	6	3	1	61
230-239	1	8	14	5	6	5	8	7	5		7	1	67
240-249	3	6	11	6	8	12	4	1	4	6	3		64
250-259	3	5	12	6	3	8	3	3	5	3	3		54
260-269		3	7	8	1	6	2	2	2	4	7		42
270-279	4	3	21	3	6	3	4	1	1	5	5	1	57
280-289	5	5	18	7	14	5		1	2	7	11	2	77
290-299	11	9	19	7	7	4	1	2	1	4	3	1	69
300-309	8	24	32	7	8	4	3		4	15	5	4	114
310-319	17	20	26	6	6	4	3	1	4	7	9	1	104
320-329	27	24	27	14	6	4	1	1	3	12	12	1	132
330-339	35	18	38	11	11	6	5		6	18	23	1	172
340-349	38	28	42	14	6	1	9	2	5	13	26	1	185
350-359	40	22	52	10	9	2	5	1	9	20	36	1	207
360-369	46	19	52	12	11	4	7	1	6	19	19	2	198
370-379	22	8	41	6	10	4	8	3	7	19	9	6	143
380-389	17	6	21	4	5	1	3	1	3	10	7	4	82
390-399	3	3	11	3	4	2	3		1	4	4	1	39
400-409	2		4	1	1					2	1		11
410-419	2	1	1	1		2			1	1	2	1	12
420-429										1	2		3
430-439									1		1		2
440-449				1						1			2
450-459	1		2										3
460-469													
470-479													
480-489	2												2
490-499													
Total	302	259	518	272	404	461	314	379	368	434	411	88	4210

Appendix A7.2. Length-frequency distribution for measured samples of Arctic cisco captured in eastward section of double trap by sampling period, Phillips Bay, 1986.

Fork Length (mm)	Number by Sampling Period												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
0- 9													
10-19													
20-29													
30-39					6	3							9
40-49					25	8	1	7		5	2		48
50-59				3	14	9	50	45	11	28	18	8	186
60-69				9	4	7	37	51	12	41	56	9	226
70-79	1			21		2	5	13	7	35	29	7	120
80-89	4		1	39	4	4	7	6	3	16	12	1	97
90-99	2		1	46	2	9	25	12	4		7		108
100-109		1		15	4	5	23	12	3	3	3	5	74
110-119	1			7	2	3	14	4	1	5	8	3	48
120-129				10	1		5	3	2	4	3	3	31
130-139				6	5		6	1	1	2	4		25
140-149				3	4	9	5	4		2	1	1	29
150-159			1	2	4	7	7	8	4	4	2		39
160-169	2		4	9	5	5	2	7		6	3	2	45
170-179			4	5	6	5		2	2	3	2	1	30
180-189		2	4	8	4	3	6	2		1			30
190-199			1	6	6	3	7	3	1	2			29
200-209	1		2	6	5	4	1	2		3	3		27
210-219	1		2	2	6	3	5	2	2	5	3	1	32
220-229			6	5	4	5	5			2			27
230-239	1	1	4	14	3	3	6	4	1	5	2		44
240-249		1	2	4	3	1		3	2	5	1		22
250-259	1	1	1	6	4	1	1	3	2	5	5		30
260-269		1	2	13	4	3	1	1	3	2	6		36
270-279	1		2	17	11	4	3	1	2	2	5	1	49
280-289	1		2	25	20	2	3	7	2	8			70
290-299	1	2	2	43	24	2		4	3	4	7	1	93
300-309	9	3	2	52	27	1	4	2	4	5	5	3	117
310-319	9	7	1	88	35		7	3	4	9	15	1	179
320-329	13	7	3	70	32	2	9	7	9	15	20	5	192
330-339	25	12	3	85	23		10	7	7	10	12	7	201
340-349	29	16	3	81	32	2	29	3	14	14	22	4	249
350-359	16	11	7	156	37	3	34	9	17	16	23	3	332
360-369	10	10	19	145	30	3	23	9	20	18	25	5	317
370-379	8	3	17	137	18	5	25	8	9	14	20	3	267
380-389	3	1	13	101	22	4	13	8	4	18	12	2	201
390-399		1	11	68	14	2	12	2	3	5	10	1	129
400-409			9	33	3		5	3	1	2	3	1	60
410-419			1	8	3		3			1	1		17
420-429		1	3	12	2			1	1		1		21
430-439			1	4	3	1					3		12
440-449				2	3	1					3		9
450-459		1								1	4		6
460-469				2							1		3
470-479				1						1	1		3
480-489													
490-499													
Total	139	82	134	1369	464	134	399	269	161	327	363	78	3919

Appendix A7.3. Length-frequency distribution for measured samples of Arctic cisco captured in westward section of double trap by sampling period, Phillips Bay, 1986.

Fork Length (mm)	Number by Sampling Period												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
0- 9													
10-19													
20-29													
30-39													
40-49				1		2				5	3		11
50-59						8	8	3	1	26	13		59
60-69				1		1	5	3		30	14		54
70-79				2		1	3	1	1	23	4		35
80-89	3	2			1	1	2			6	2		17
90-99	1	1		1		4	7	2		1	1		18
100-109						5	13			2			20
110-119	1			2	1	1	7	1	1				14
120-129					1	2	4			3			10
130-139		1			1					1	1		4
140-149	3	1					3			1			8
150-159			1				3	1		4			9
160-169						1	3		1	1	1		7
170-179		2			1		2		3	1			9
180-189	1						3	1	1				6
190-199							3		2	1			6
200-209							2	1	1				4
210-219		1	1		2		2	2	1				9
220-229		1	2	4				1	1	2			11
230-239	2			2	3		1	1	3	5			17
240-249		1	1	1			4		4	5	3		19
250-259	1			2			3	1		1			8
260-269				4	1		6	2	1	4	2		20
270-279				7	3	1	5	5	1				22
280-289		2	3	3	4	1	6	2	6	3	5		35
290-299	2	1	2	9	5	2	7	3	1			1	33
300-309	4	7	4	8	3		6	6	1	1		2	42
310-319	15	7	3	14	6	4	12	4		4	3	1	73
320-329	16	5	1	13	10		22	8	3	2	5	1	86
330-339	22	11	7	20	8	3	25	3	4	4	6	1	114
340-349	20	5	5	23	12		26	2	4	4	6	2	109
350-359	13	6	4	21	14	4	47	4	8	3	4		128
360-369	17	5	11	25	14	3	40	12	6	5	5		144 [1]
370-379	7	1	7	25	7	4	21	3	2	4		1	82
380-389	5	3	2	9	11	1	11	3	2	3	2		52
390-399	2		7	3	5	1	6	1			1	1	27
400-409	1		1	5	1		3		2	1	1		15
410-419			1	1	1		4				2		9
420-429					1		2						3
430-439				1									1
440-449							1						1
450-459				1									1
460-469				1					1				2
470-479													
480-489													
Total	136	63	63	209	116	50	328	76	62	156	84	10	1354

[1] One fish in this size range could not be placed as to cycle.

Appendix A7.4. Length-frequency distribution for measured samples of least cisco captured in single trap by sampling period, Phillips Bay, 1986.

Fork Length (mm)	Number by Sampling Period												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
0-9													
10-19													
20-29													
30-39													
40-49												1	1
50-59						1			1		1		3
60-69				3	4	5	1		1	4	2		20
70-79			1	3	39	10	2	1	3	3	3	1	66
80-89				10	52	26	5	5	12	2	5		117
90-99				5	34	35	19	37	21	10	9	3	173
100-109				8	21	22	12	45	41	24	14	4	191
110-119			1	2	12	21	6	50	22	30	30	7	181
120-129				1	1	12	4	17	22	33	33	9	132
130-139				2	3	10	6	21	10	21	27	8	108
140-149			1	4	6	16	4	19	5	9	20	1	85
150-159				3	4	11	14	34	15	19	17	4	121
160-169	1	2		5	7	7	17	31	23	21	20	1	135
170-179	1	1	1	1	5	8	6	17	21	16	13	2	92
180-189	1	1	2	5	7	5	4	15	12	8	13	3	76
190-199		2		4	2	6	4	7	3	6	6		40
200-209	1	5	1	8	11		4	6	7	8	7	3	61
210-219	1	5	2	11	6	3	6	7	4	3	1		49
220-229	2	4	2	11	5	4	2	8	1	3	1		43
230-239	4	4	3	9	12	3	2	4	1	1			43
240-249	8	9	4	6	8		4	1	3		4		47
250-259	7	5	7	1	10	8	2	1	1	3	2		47
260-269	8	7	9	14	8	19	12	4	2	5	2		90
270-279	19	19	15	15	12	15	13	8	6	8	5	1	136
280-289	35	43	26	17	46	44	15	8	7	11	5		257
290-299	43	48	46	27	27	42	21	12	12	14	15		307
300-309	26	32	43	19	24	27	18	8	2	7	19		225
310-319	17	26	30	17	8	13	14	11	8	7	7		158
320-329	7	16	17	2	7	7	8	7	2	6	8		87
330-339	6	4	2	2	3	1	4	2	2		2		28
340-349	1	5	1			2	1			1	1		12
350-359			1		1								2
360-369													
370-379	1												1
380-389													
390-399													
Total	189	238	215	215	385	383	230	386	270	283	292	48	3134

Appendix A7.5. Length-frequency distribution for measured samples of least cisco captured in eastward section of double trap by sampling period, Phillips Bay, 1986.

Fork Length (mm)	Number by Sampling Period												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
0-9													
10-19													
20-29													
30-39													
40-49											1		1
50-59					3	1	1			1	7		13
60-69				4	1	1		1	3	3	21		34
70-79				6	6	3	1	1			9		26
80-89				4	3	4	3	3	4	3	4		28
90-99				5	7	1	12	9	6	5	3		48
100-109				7	1	3	30	7	13	7	8	1	77
110-119			1	2	1	3	18	4	7	18	9	1	64
120-129		1		3	2	2	12	1	2	13	4	1	41
130-139				5	2	11	11	3	4	9	5	1	51
140-149				7	8	10	15	7	5	8	2		62
150-159		1		1	6	18	25	14	8	16	3	2	94
160-169				1	6	25	21	13	19	25	6	1	117
170-179				3	2	15	10	17	6	5	6	1	65
180-189				3	6	12	9	14	6	5	4		59
190-199				3	3	10	3	5	3	4	3	1	35
200-209	1			1	1	9	6	8	3	3			32
210-219	2			1	2	5	5	6	2	5	1		29
220-229	3	1		3	2	6	4	1	2	1	1	1	25
230-239	1	2		2	3	2	2	5	4	1			22
240-249		4		5	3	3	6	5			1		27
250-259	6	1		4	10	1	4	5	2	1	1		35
260-269	13	8	2	8	11	3	7	4	4	1	2	1	64
270-279	33	12	7	23	31	10	10	9	7	1	4		148
280-289	45	21	16	22	46	19	13	15	7	6	7	1	218
290-299	67	32	23	40	44	10	27	18	12	7	10	1	291
300-309	74	30	22	38	25	13	18	26	5	7	13	1	272
310-319	31	16	14	33	14	8	13	28	10	8	8	1	184
320-329	12	5	7	14	9	5	15	8	3	4	10	1	93
330-339	4	2	3	6	7	6	6	11	4	2	8	1	60
340-349	1			2	3	3	9	3	5		6	2	34
350-359					4		5	2		1	3		15
360-369							2				1	1	4
370-379				1									1
380-389	2							1					3
390-399							1						1
Total	295	136	95	258	272	222	324	254	156	170	171	20	2373

Appendix A7.6. Length-frequency distribution for measured samples of least cisco captured in westward section of double trap by sampling period, Phillips Bay, 1986.

Fork Length (mm)	Number by Sampling Period												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
0-9													
10-19													
20-29													
30-39											1		1
40-49													
50-59										1	4		5
60-69										1	3		4
70-79						1	1			1	1		4
80-89				1		2	2		1	2			8
90-99				1	5	3	14			2	3		28
100-109				1	2	4	14	1	4	3	1		30
110-119					2	3	11	3	1	7	3		30
120-129						3	10	1		13	2		29
130-139	1			1	1		3	9		1	6	3		25
140-149					1	2	4	10	2		5	1		25
150-159					1	5	2	16	6	8	3		1	42
160-169				1	1	2	4	11	3	4	6	2		34
170-179					1	4		7	4	3	6	3	1	29
180-189								5	3	4	6	4		22
190-199	1				1	1	1	5	1	4	1			15
200-209	1				1			3	2	5	1	1	1	15
210-219	2	1			2		1	4	4	3	1			18
220-229		1			4			3	1	3	1			13
230-239	3				2	3		1	3		4			16
240-249	1	2					1	5		1	1			11
250-259	4	2	1	2	1	3	4	2	1					20
260-269	14	5	2	3	4	2	12	4	3	1				50
270-279	23	10	6	12	9	10	18	14	11		1	1		115
280-289	35	18	14	27	16	24	31	21	9	2	1	1		199
290-299	37	19	21	37	24	23	26	13	15	1	1			217
300-309	43	19	19	29	33	29	19	18	12	2	1	1		225
310-319	15	17	16	52	28	21	15	17	9		2			192
320-329	6	9	11	21	15	7	8	5	3		1			86
330-339	2	2	3	15	8	5	3	3			1			42
340-349	2	1	1	4	2	1	2							13
350-359			1			1		1						3
360-369														
370-379														
380-389														
390-399														
Total	190	106	97	220	166	158	269	132	105	77	40	6	1566

Appendix A8. Mark-recapture information for fish tagged at Phillips Bay, Yukon coast, 1986[1].

Species	Release Date	Recapture Date	Recapture Location	Elapsed Time (Days)
Arctic cisco	23 June-3 July 1986	25 June 1986	Phillips Bay	≤2
"	23 June-3 July 1986	28 June 1986	Phillips Bay	≤5
"	23 June-3 July 1986	30 June 1986	Phillips Bay	≤7
"	23 June-3 July 1986	25 Aug 1986	Phillips Bay	≥54
"	23 June-3 July 1986	26 Aug 1986	Phillips Bay	≥55
"	23 June-3 July 1986	27 Aug 1986	Phillips Bay	≥56
"	23 June-3 July 1986	31 Aug 1986	Phillips Bay	≥60
"	23 June-3 July 1986	2 Sept 1986	Phillips Bay	≥62
"	8 July 1986	26 July 1986	Phillips Bay	18
"	9 July 1986	16 July 1986	Shingle Point	7
"	11 July 1986	1 Sept 1986	Phillips Bay	52
"	14 July 1986	28 Aug 1986	Phillips Bay	45
"	14 July 1986	2 Aug 1986	Shingle Point	19
"	14 July 1986	16 July 1986	Phillips Bay	2
"	16 July 1986	14 Aug 1986	Shingle Point	29
"	19 July 1986	27 July 1986	Shingle Point	8
"	22 July 1986	4 Aug 1986	Shingle Point	13
"	26 July 1986	20 Oct 1986	Peel Channel[2]	86
"	9 July 1986	Autumn 1987	Indian Village[2]	≈450
"	13 July 1986	Autumn 1987	Indian Village[2]	≈450
"	13 July 1986	Autumn 1987	Indian Village[2]	≈450
"	13 July 1986	Autumn 1987	Indian Village[2]	≈450
"	13 July 1986	August 1987	Reindeer Depot[2]	≈390
"	5 Aug 1986	Autumn 1987	Indian Village[2]	≈425
"	12 July 1986	15 Aug 1988	Barter Island	768
Least cisco	23 June-3 July 1986	27 June 1986	Phillips Bay	≤3
"	23 June-3 July 1986	28 June 1986	Phillips Bay	≤4
"	23 June-3 July 1986	24 July 1986	Phillips Bay	≥22
"	23 June-3 July 1986	24 July 1986	Phillips Bay	≥22
"	23 June-3 July 1986	2 Aug 1986	Phillips Bay	≥31
"	23 June-3 July 1986	3 Aug 1986	Phillips Bay	≥32
"	23 June-3 July 1986	4 Aug 1986	Phillips Bay	≥33
"	23 June-3 July 1986	6 Aug 1986	Phillips Bay	≥35
"	23 June-3 July 1986	7 Aug 1986	Phillips Bay	≥36
Arctic charr	23 June-3 July 1986	24 June 1986	Phillips Bay	1
"	23 June-3 July 1986	26 June 1986	Phillips Bay	≤3
"	23 June-3 July 1986	26 June 1986	Phillips Bay	≤3
"	23 June-3 July 1986	27 June 1986	Phillips Bay	≤4
"	23 June-3 July 1986	28 June 1986	Phillips Bay	≤5
"	23 June-3 July 1986	29 June 1986	Phillips Bay	≤6
"	23 June-3 July 1986	29 June 1986	Phillips Bay	≤6
"	23 June-3 July 1986	30 June 1986	Phillips Bay	≤7
"	23 June-3 July 1986	30 June 1986	Phillips Bay	≤7
"	23 June-3 July 1986	1 July 1986	Phillips Bay	≤8
"	23 June-3 July 1986	1 July 1986	Phillips Bay	≤8
"	23 June-3 July 1986	2 July 1986	Phillips Bay	≤9
"	23 June-3 July 1986	3 July 1986	Phillips Bay	≤10
"	23 June-3 July 1986	4 July 1986	Phillips Bay	≤11
"	23 June-3 July 1986	4 July 1986	Phillips Bay	≤11
"	23 June-3 July 1986	4 July 1986	Phillips Bay	≤11
"	23 June-3 July 1986	4 July 1986	Phillips Bay	≤11
"	23 June-3 July 1986	4 July 1986	Phillips Bay	≤11
"	23 June-3 July 1986	4 July 1986	Phillips Bay	≤11
"	23 June-3 July 1986	4 July 1986	Phillips Bay	≤11
"	23 June-3 July 1986	4 July 1986	Phillips Bay	≤11
"	23 June-3 July 1986	25 Aug 1986	Phillips Bay	≥53

[1]23 June-3 July 1986 indicates fish fin-clipped. Specific day not known.
[2]Mackenzie Delta.